PC 2001 System Design Guide

A Technical Reference for Designing PCs and Peripherals for the Microsoft® Windows® Family of Operating Systems

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IMPORTANT: This is a working draft of proposed revisions to the system design guidelines, subject to change and addition throughout the industry review process.

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Welcome and Executive Summary

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This guide is for engineers who build personal computers, expansion cards, and peripheral devices that will be used with the Microsoft® Windows® 2000 and Windows 98 operating systems. The goal of this document is to provide guidelines for hardware design that will result in the optimal user experience, particularly when the hardware is used with the Windows family of operating systems.

This guide is co-authored by Intel Corporation and Microsoft Corporation. The requirements in this guide indicate features that the hardware industry should consider in designing PCs and peripherals for various price levels and performance levels.

The clarifications, changes, and additional requirements in this guide include extensions and modifications to the requirements defined in *PC 99 System Design Guide* (Microsoft Press, 1998; ISBN 0-7356-0518-1).

This guide includes PC 2001 requirements for basic consumer and office implementations, such as desktop, mobile, and workstation systems, and for Easy PC systems. In this guide, the following requirements are defined:

?? Design requirements for specific types of systems that will run either Windows 98 or Windows 2000 operating systems

?? Design requirements related to the Easy PC Initiative, including requirements for legacy-free PC systems

?? Design requirements for devices supported under Windows 98 and Windows 2000, including graphics and video device capabilities, digital media, storage, networking and communications, and other devices

This guide does not address PC systems designed to act as servers in networked environments. It also does not address non-PC handheld computers running the Microsoft Windows CE operating system.

NOTE to REVIEWERS: Please look for comments such as this in the draft, which encourage your feedback on specific issues.

Please submit comments using the form on http://www.pcdesguide.org or by sending e-mail to comments@pcdesguide.org.

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Executive Summary

Note to Reviewers: Please see the instructions for submitting comments that you received with your review package, or see the web site at http://www.pcdesguide.org.

The following overall changes in presentation are provided in PC 2001, in comparison to *PC 99 System Design Guide*:

?? PC 2001 contains only requirements, with no recommended or optional items.

?? Removal of redundant requirements. Items such as Plug and Play and driver installation requirements are stated once, with only cross-references supplied in other chapters.

?? Bus requirements have been collected into one chapter.

?? The following topics—which have been repeated throughout the history of PC Design Guides and have no new changes for this draft—have been removed and collected in a reference library on the web at http://www.pcdesguide.org:

  ?? *Legacy Plug and Play Guidelines*

  ?? *Design Guidelines for PC Card and CardBus*

?? Guidelines that were introduced since *PC 99 System Design Guide* are marked with [NEW.*xx.yyy*] where the *x* and *y* digits are a temporary number.

?? Many deleted items have been moved from the place they appeared in PC99 because PC 2001 emphasizes legacy free and drastic legacy-reduced

designs—so the legacy-related design guidelines have been relocated as described above, but remain requirements.

Some requirements have been removed because those features are no longer important to the industry, or they are no longer relevant in defining the optimal user experience with the Windows operating system.

Note to Reviewers: Please comment on the utility of this organization in relation to how you use this guide.

Key PC 2001 Initiatives: Easy PC and Legacy Removal

The Easy PC Initiative describes a technology vision for making the Windows platform easy to use. The key goal is to produce new PC products that are easy to set up, easy to use, and easy to expand, and that allow system designs to create new form factors.

The Easy PC Initiative presents the most ambitious challenge for the industry: to remove the legacy hardware, firmware, and ergonomic barriers to PC use, and to create exciting new PC designs that will both advance the platform and attract new classes of PC users. In this draft, the Easy PC Initiative is summarized in Chapter 2.

A PC 2001 system, however, can also be designed to meet the requirements for so-called legacy free design, where the operating system does not detect and the end user does not have access to legacy components such as serial or parallel ports or floppy disk controllers.

In this draft, the specific PC 2001 requirements for legacy free systems are summarized in Chapter 4, “PC 2001 Core System Guidelines.”

System Requirements

This section provides a general summary of requirements in *PC 2001 System Design Guide*.

Core and Desktop System Requirements

Basic requirements. All PC 2001 systems must meet the following requirements:

?? Performance equivalent to the CPU, cache, and memory combination that is expected to be the minimum baseline for 2001.

For desktop systems, this is equivalent to:

?? Processor speed is 500 MHz, minimum.

?? Cach size is 128 KB, minimum.

- ?? RAM is 64MB, minimum.

?? APIC implemented and properly connected.

?? ACPI properly implemented, based on ACPI 1.0b, plus any changes to the ACPI specification adopted in 1999. Power management is implemented for each device, based on the related specifications for each device class. Clarifications for power button implementation are provided.

These new power management-related requirements are defined for PC 2001:

- ?? System supports S3, S4, and S5 states, and USB host controller, plus all devices that support wake-up capabilities must support wakeup from the S3 plus one additional sleep state.
- ?? System implements ACPI 1.0b thermal model and fan control.
- ?? BIOS handoff to the operating system occurs in seven seconds or less, and resume from S1-S3 states must occur within 500ms. (Criteria and exclusions are defined in the related requirement.)

?? BIOS support for CD/DVD boot, USB boot devices, network boot, unique system ID, security, updates, and debugging.

?? System and devices compliant with accessibility, Plug and Play, and driver installation guidelines, and implement icons and color-coded connectors.

?? Support for a LAN connection and public network communications.

?? Other device and bus requirements as defined in the separate chapters.

Legacy reduction and removal. Legacy reduction requirements for all PC 2001 systems include:

?? No ISA slots or devices.

?? No legacy FDC.

?? No reliance on MS-DOS for any software components provided with the system.

Additional legacy removal requirements for systems that are identified by the operating system as “legacy free” include:

?? No boot dependencies on ISA or other legacy devices.

?? No operating system detection or user-accessible connectors for external serial, parallel, or PS/2 (8042 controller) ports, and no use of related port addresses.

?? BIOS support for specific ACPI changes to support “legacy” and 8042 flags, ACPI reset mechanism, and Debug Port Table.

Workstation PCs

?? Performance is equivalent to:

- ?? Processor speed is 700 MHz, minimum.
- ?? Cach size is 512 KB, minimum.
- ?? RAM is 128MB, minimum, with expandable RAM and ECC memory protection.

?? Support for multiple processors, based on ACPI 1.0b and MPS v. 1.04.

?? Bus, bridge, and adapter requirements related to 64-bit architecture and related PCI bus issues.

?? Requirements for multiple hard-drive storage systems, when multiple hard drives are implemented.

Mobile PCs

?? Performance is equivalent to:

- ?? Processor speed is 600 MHz, minimum.
- ?? Cach size is 128 KB, minimum.

?? Clarifications for battery and docking requirements.

Easy PC

?? Not defined in this draft.

Bus and Device Class Requirements

Buses and Interfaces

USB:

?? USB required for all system types, with four ports required for desktop and workstation systems, and one port for Mobile PCs.

?? At a minimum, all USB components must comply with and meet full bandwidth specified in USB v.1.1.

?? If USB 2.0 support is included in the system, it must comply with USB 2.0 specification.

?? Host controllers must comply with Open HCI, UHCI, or USB 1.1 host controller specification.

?? Host controllers on the motherboard must support wakeup from S3. All components must support power management as defined under USB 1.1 and the USB Common Class Specification, v.1.1.

?? All hubs except hubs on USB keyboards must be self-powered.

IEEE 1394:

?? If system includes IEEE 1394, support IEEE 1394-1995/1394a interconnectivity.

?? If system implements IEEE 1394 internal devices, support the IEEE p193b amendment to IEEE 1394-1995.

?? Host controllers support 1394 OpenHCI 1.1 and minimum peak data rates specified in IEEE 1394 specifications.

?? Configuration ROM complies with IEEE 1394 and IEEE 1212r-2000 standards, and power management complies with 1394 Trade Association Power Specification.

SCSI:

?? Controllers comply with SPI-3 standards, and support bus mastering and virtual DMA.

?? Bootable SCSI controllers support El Torito, and option ROMs support Int 13h extensions.

?? Connectors, termination, data protection, Plug and Play, and power management requirements remain as defined in *PC 99 System Design Guide*.

ATA and ATAPI:

?? Controllers comply with ATA/ATAPI-5, and support Ultra DMA.

?? Bootable controllers support El Torito, and option ROMs support Int 13h extensions.

?? Connectors, Plug and Play, and power management requirements remain as defined in *PC 99 System Design Guide*.

PCI:

?? PCI Revision 2.2 and *PCI Bus Power Management Interface Specification*, Revision 1.1 are defined as standards for the bus and devices.

?? Clarifications are provided for power management and 3.3Vaux requirements.

?? For systems that support PCI-X, all related components must comply with PCI-X 1.0 specification.

Input Devices

?? All non-integrated input devices comply with HID 1.1 specifications, and all devices meet the Plug and Play, power management, and other implementation specifications for their device class and bus connectors.

?? Wireless components use NDIS 5.0 miniport drivers and comply with their related industry specifications.

?? The system must provide a separate, physically-isolated transceiver for each IR protocol supported.

?? Smart card devices comply with ISO 7816 requirements.

Graphics

?? If a digital interface is implemented, it must comply with Digital Visual Interface (DVI) specifications, for both graphics adapters and monitors.

?? Primary graphics adapter uses AGP 2x or other high-speed connection.

?? Systems must support a minimum resolution of 1024x768, 32 bpp, double buffered in 2-D mode, and 1024x768x16-bit bpp, double buffered, 16-bit Z in 3-D mode. Desktop systems must support hardware-accelerated 3-D graphics.

?? Clarifications provided for external display interface, color management, and 2-D requirements for the graphics adapter.

?? 3-D acceleration requirements advanced to match current state of the industry and Microsoft DirectX® implementation.

?? Plug and Play, power management, and multiple monitor/multiple adapter requirements are unchanged from *PC 99 System Design Guide*.

?? Clarifications for TV output, if this is implemented in the system.

?? Clarifications and quality advances for graphics subsystem support for video: support for TV/DVD playback at 1280x720 or larger.

?? Specific implementation guidelines for mobile PC systems.

Video

?? All PC 2001 desktop systems support video playback in 1024x768, 32 bpp mode and 8-bit alpha blending of video required in 32-bit mode. (Mobile exceptions are called out for several requirements.)

?? Systems with DVD-Video playback capabilities must correctly implement DVD decoders to ensure seamless navigation and quality decoding.

?? All streams (including data streams) received by receiver modules must be available to the host.

?? Systems that support digital TV must have All Format MPEG decode support (that is, decode support for up to six times standard definition rates).

?? Clarifications are provided related to the ever-increasing demand for improved video quality on the PC platform.

Monitors

?? Both digital and analog monitors must be DDC2B-compliant and support Integrated Color Management, with resolution requirements based on monitor size.

?? Both digital and analog monitors must synchronize to a new format in less than three seconds.

?? Digital interface, if implemented, must be DVI compliant, with additional requirements for power state transitions and Hot Plug detection.

?? Clarifications for host control on large-format monitors: meet USB or VESA standards.

Audio

?? PC 2001 requires that audio hardware does not utilize legacy interfaces under both Windows and MS-DOS. As defined in previous design guides, digital audio requirements specify audio buffer management guidelines and other features to ensure the system is “digital ready.”

?? Some additions are defined for the audio minimum performance requirements over *PC 99 System Design Guide*. (Some exceptions for mobile PCs are noted.)

?? Performance and feature requirements are defined for 2-D and 3-D hardware acceleration and DLS acceleration, if these capabilities are implemented.

?? Clarifications and new requirements for microphone input are defined, to support voice-input applications.

Modems

?? Modem drivers must include Unimodem support.

?? Minimum modem support includes V.250 AT command set, V.90, V.80, V.42 LAPM, V.42bis, V.251, and T.31 FAX modem.

?? Requirements are defined for optional implementation of TDD support, voice mode, and Caller ID.

?? Requirements for Plug and Play, power management (including wake-on-ring), and installation are the same as for *PC 99 System Design Guide*.

?? New requirements are defined for the modem subsystem on riser cards.

?? Driver-based modems must use a WDM driver solution.

?? ISDN modem must support basic AT commands plus commands to select the end-to-end protocol, set switch type, and subscriber numbers. ISDN modems must also support RFC 1662.

?? All external modems (including ISDN modems) must support USB and USB CDC, v. 1.1.

?? Requirements are provided for mobile modems that implement wireless or digital cellular support. Requirements are also provided for telephony applications included with a PC 2001 system.

Networking

?? All network adapters must use an NDIS 5.0 miniport driver.

?? The adapter must detect the network dynamically, sense transceiver type, and meet other standard requirements for data transmission.

?? Network adapters on a system with Windows 2000 preinstalled must provide PXE remote boot support.

?? Specific requirements are defined for IEEE 802 LAN, ISDN, cable modems, ATM adapters, and ADSL, with minimal changes over *PC 99 System Design Guide*.

?? IrDA network devices must support FIR and SIR.

?? All external networking devices must use USB or IEEE 1394, and corresponding standard control protocols where applicable.

?? Home networking guidelines specify which LAN adapter requirements apply for adapters intended for home markets. Home networking media must support IP and related specifications for media choice, such as HomeRF or HomePNA.

?? Requirements for Plug and Play, power management (including wake-on-LAN), and driver installation are unchanged from *PC 99 System Design Guide*.

Storage

?? Storage components and optical devices must support bus mastering, and most device types must support media status notification.

?? Any floppy disk drive implementation must not use the legacy FDC.

?? Clarifications for CD drives, which must comply with MMC-2, support multisession capabilities and detect digital audio.

?? Clarifications for DVD drives, with requirements to support all DVD formations, including DVD-RAM, DVD+RW, and others. DVD drive must meet most CD drive requirements, and must also support defect management and copyright protection.

?? Requirements for CD and DVD read rates are altered to allow faster, broader acceptance of CDR/RW, and DVD rewritable formats where error correction and defect management are imperative.

?? All common option ROM and connector requirements are consolidated for easy reference. Similar consolidation for common bus and storage items.

?? Installation, power management, and driver requirements are unchanged from *PC 99 System Design Guide*.

Printers and Digital Still Imaging

?? Printers must have a USB or IEEE 1394 interface, which can be provided in addition to any legacy connection, such as serial or IEEE 1284.

?? Still image devices must use USB, IEEE 1394, or SCSI (for scanners).

?? Digital still cameras must meet throughput requirements, based on the type of connection.

?? Color matching requirements for digital imaging devices and printers include sRGB output and new Delta E tolerance requirements.

?? Each printer and digital still imaging device must support sRGB output and have an ICC profile.

?? A printer driver must be based on Unidriver and not run in kernel mode.

?? USB camera requirements are defined, including support for USB Still Image Device Definition specification and ISO 15740.

?? Still image device drivers must be implemented under Windows Image Acquisition driver architecture.

How to Use This Guide

The PC 2001 requirements are defined by system architecture and for individual bus classes and device classes.

PC 2001 V.0.3 Draft Organization

This design guide is divided into three parts.

?? **Part 1: System Design Issues and Initiatives.** Introduces important design issues and the latest initiatives for PC 2001. Study this part first to understand the key design issues and initiatives addressed in the PC 2001 requirements.

Note to Reviewers: In v.0.5, only the Easy PC Initiative is presented in detail.

?? **Part 2: System Design Guidelines.** Presents system-type definitions and PC 2001 requirements for each system type. Study this part for an understanding of the overall system requirements.

?? **Part 3: Device Class Subsystem Design Guidelines.** Presents requirements for each device class supported under Windows 2000. Study this part for a detailed understanding of how devices are implemented on PC 2001 systems.

?? **Appendixes.** Includes the PC 2001 checklist, which summarizes all the requirements defined in this guide, plus other technical appendixes.

Updates to PC 2001 and other PC design guidelines, technical clarifications, and answers to frequently asked questions are available on the web site at http://www.pcdesguide.org.

Conventions Used in This Guide

In this guide, hardware features are **all** described as *Required.* For PC 2001, the following terms have these specific meanings:

?? **Required:** These basic features must be implemented in order for hardware to comply with PC 2001 requirements.

?? **If implemented…:** These features add capabilities that are supported by the Windows family of operating systems. These features take advantage of the native capabilities of the drivers included with the operating system, usually without imposing major cost increases. These features do not have to be implemented. The related item states what is required if the feature is implemented.

IMPORTANT: The requirements in this guide are often provided in the form of references to industry specifications. These specifications might contain intellectual property of Intel, Microsoft, or other third parties. Each of these industry specifications might have different intellectual property licensing arrangements. It is the responsibility of the original equipment manufacturer (OEM) to consult these industry specifications or their issuance bodies for licensing specifics or details.

The following conventional terms are used throughout this guide. In addition, see the Hardware Glossary in the References part of this guide.

Convention	Meaning
Add-on device	Refers to devices that are traditionally added to the basic PC system to increase functionality. Examples include audio, networking, graphics, small computer system interface (SCSI) controller, and so on. Add-on devices fall into two categories: devices built onto the system board and devices on expansion cards added to the system through a system-board connector, such as Peripheral Component Interconnect (PCI).
Intel Architecture	Refers to computers based on 32-bit or 64-bit microprocessors that use the Intel Architecture instruction set, such as Intel® 80486, Intel Pentium®, Pentium Pro, Pentium II, Pentium III or compatible processors.
PC 2001	Collection of the additional requirements and recommendations defined in this guide that make up the 2001–2003 requirements for PC system design.

System device	Also *on-board device*. Refers to devices on the system board, such as interrupt controllers, keyboard controller, real-time clock, direct memory access (DMA) page registers, DMA controllers, memory controllers, floppy disk controller (FDC), hard disk controller (HDC), serial and parallel ports, PCI bridges, and so on. In today's PCs, these devices are typically integrated with the supporting chip set.
Windows	For PC 2001, refers to both Microsoft Windows 98 and Windows 2000 operating systems.
Windows 98	For PC 2001, refers specifically to the Microsoft Windows 98 operating system, including any add-on capabilities and any later versions of the operating system.
Windows 2000	For PC 2001, refers specifically to the Microsoft Windows 2000 Professional operating system, including any add-on capabilities and any later versions of the operating system.

References

The following table lists some of the information resources, services, and tools available from Intel and Microsoft to help build hardware that is compliant with the PC 2001 requirements. In addition, each chapter in this guide contains a reference section.

Resource	Address
Intel information for developers	http://developer.intel.com
Microsoft information for hardware manufacturers	http://www.microsoft.com/hwdev/ E-mail: ihv@microsoft.com
Windows 98 and Windows 2000 Driver Development Kits (DDKs)	http://www.microsoft.com/ ddk/ Also provided with Microsoft Developer Network (MSDN) Professional membership. To subscribe: Fax: (425) 936-7329, Attn: Developer Network E-mail: msdn@microsoft.com http://www.microsoft.com/msdn/subscribe/
System Test Implementers Forum	http://www.systemtest.org
Microsoft Windows Hardware Quality Labs testing tools	http://www.microsoft.com/hwtest/

CHAPTER 2

Easy PC Initiative

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Contents

The Easy PC industry initiative, jointly announced by Intel and Microsoft in 1999, builds on a foundation laid in earlier versions of the system design guide and adopted by the industry. This chapter describes the shared vision for making the PC platform simpler—especially for new users. The initial emphasis for the Easy PC Initiative is on the Consumer Desktop based on Microsoft Windows "Millennium." This chapter gives you a framework for ease of use related guidelines in the following chapters and cites the key issues to be addressed in each of the Easy PC platform focus areas in the *PC 2001 System Design Guide.* Chapter 7 provides guidelines specific to the Easy PC platform.

Note to Reviewers: Industry will review Chapter 7 through a separate and open review process in parallel with review of the system design guide. Registered reviewers will be informed of the availability of all interim drafts of the "Easy PC Requirements" chapter. If this material has been through a full industry review by the 0.7 draft cutoff, this chapter will be considered for incorporation into the version 0.7 draft of this guide.

The key goal for the Easy PC Initiative is to produce new PC products that are easy to set up, easy to use, easy to expand, and easy to maintain. Guidelines that are common to all platforms, found in Chapter 4, support many of these features. End users will benefit from simplification and related design innovations,

including new form factors and improved accessibility. The industry will benefit from reduced support costs by removing PC configuration problems.

For additional information about the Easy PC Initiative, see the related web sites from Intel at http://developer.intel.com/technology/easeofuse/ and from Microsoft at http://www.microsoft.com/hwdev/newpc/.

Ease of Use Goals in PC 2001

This section identifies key areas of advancement that are advocated under the Easy PC Initiative. This view of the system from the user's perspective serves as the context for guidelines in chapters 4 and 7. Many of these guidelines extend focus areas that were identified in earlier guides.

Easy to Set Up

The setup process has been shown to confuse first-time and non-technical users. The goal is to get the user from “PC in box” to “PC in use” with a straight forward, satisfactory result, and no prior knowledge required of the user. The Out of Box Experience (OOBE), as it's called, should be an easy, fast, and friendly first-use experience that enables a novice user to set up a new Windows-based PC and begin using it with no outside assistance.

Windows 98 Second Edition and Windows Millennium have features that provide support for OEMs to improve the OOBE for new systems. Using Microsoft-provided tools, the manufacturer can create streamlined installation routines to preinstall the operating system. Integrated Internet signup and registration gives the manufacturer flexibility for customizing and preconfiguring dial-up connectivity. The system setup provides easy, single-stop data entry for customer sign-up and registration information for preconfigured software and other components. Other advancements for manufacturer branding and customization include ISP signup, browser customization, tutorials, error screens, and more.

The Easy PC Initiative promotes total preconfiguration by the system manufacturer of applications, connectivity, and other activities that have been shown to confuse first-time and non-technical users. System builders are strongly encouraged to take advantage of all the features of Windows Millennium to preconfigure settings and make it easy for users to intuitively operate their computers.

Manufacturers should pay special attention to making sure that the user’s experience from box to desktop is quick and simple. The following design considerations are setup “best practices” for an OOBE that is easy and trouble-free.

?? Label all boxes to show the order for opening

?? Ensure packaging permits easy removal.

?? Use required icons and color-code connectors].

?? Include a setup map with the PC, keyed to the labels on the boxes and, where possible, color-coded to match connector colors.

?? Use the Microsoft-provided tools to preconfigure the system for easy use.

?? The system should to be configured ready for broadband (DSL and cable modem) connectivity and home networking or easily upgradeable by the user.

?? Design for reduced cable clutter—for example, use a single power cable; collect peripheral cables together in a single bundle.

?? Design well integrated and reduced-form factor solutions.

?? Design in button and indicator guidelines, including improved solutions for placement, labeling, and functionality.

Easy to Use

The PC is one of the more powerful, flexible and necessarily sophisticated devices that the average person will use. On the other hand, these characteristics may be daunting to new users who need simplicity. The goal is to maintain the PC's power and flexibility, while presenting the user with simplified, intuitive access to information and system functionality.

Starting with first use, hardware and software must be easily discoverable and immediately usable in a forgiving environment. Common tasks that are performed frequently should be easy to find. Communication with the user should be in easy, understandable, non-technical terms. These improvements can be accomplished through a combination of hardware, firmware, operating system and applications.

Overall, the PC should have improved robustness and reliability, enabled via reduction of fragile legacy hardware and software, plus adoption of self-repairing features. Recovery from failure should be graceful. Any user notification of machine state should be relevant and comprehensible. As newer technologies are incorporated, place particular emphasis on integration and user experience. Suspend and resume power management features should be fast and reliable. Networking should be automated and transparent. User preferences in the areas of sharing, privacy and personalization should be easily comprehended and readily configured.

An Easy PC must deliver robust, available-on-demand capability. The corresponding Intel and Microsoft enabling initiatives are Instantly Available and On Now. The Instantly Available/ On Now architecture includes the following design elements:

?? An ACPI BIOS that provides both system controlled configuration and power management of systems and devices

?? Dual-mode power delivery that provides headroom for normal operation and auxiliary power during suspend and wakeup

?? Low noise cooling in the operational state

?? Silent operation in the suspended state

?? Software aided budgeting of auxiliary power and management of power states including configuration of wakeup sources

The platform implementation should ensure that the user has no reason to reboot the PC between use sessions. The user must see the PC as instantaneously available, with a startup experience similar to turning on a TV, so as to encourage spontaneous and frequent use. The Easy PC should exhibit the following attributes: robustness across multiple sessions, easy and rapid on/off, quiet operation in the on state, low wattage in the off state, responsive to network and modem wakeup from the off state, comprehend dynamic reconfiguration of USB and network subsystems.

Towards delivering Instantly Available/ On Now capability, some areas need focus. These are discussed next in some detail. :

Noise Containment during operational and sleep states: This implies minimizing noise generated from fans and disk drives.

Design techniques to minimize fan noise include placement and sizing of one or more fans within the chassis and minimizing fan speed. The selection and placement of the fan(s) is important, since fan noise can be attenuated within the chassis. Equivalent airflow from large fans can be delivered at lower rpm than smaller fans, resulting in lower noise. Internal baffles and ducts can be used to direct airflow optimally. Fans that pull air into the chassis are more efficient than fans that blow air out of the chassis. Placement of fans should direct the air outlet away from the user. In particular, the fan should not switch intermittently between full on and off, which is even more distracting to the user than having the fan be always on. Linear control of fan speed, matched to system cooling requirements is preferred.

In the suspended state, the implementation must support self-cooling without use of the fan other than possibly as a failsafe backup for unusually high ambients.

Quick availability, by utilizing sleep states and minimizing reboots. The Easy PC should have robust power management comprehending all subsystems and supported power states. If the power management is not reliable, the user will prefer to shutdown and reboot the system with each use, effectively limiting the use of the PC to "big" tasks. The Easy PC implementation must comprehend expansion of hardware and software functions to the initial configuration.

Elimination of unnecessary Boot steps. The Easy PC delivers a rapid and silent boot without intermediate screens. The ACPI configuration tables, removal of legacy interfaces and Simple Boot Flag implementation should be leveraged fully.

Any diagnostic modes or setup screens should not be entered during normal boot sequence. Simplification focus areas include Option ROMs and network adapters.

Simple User Interface for On/Off and common functions. A Sleep/Wakeup button, that operates like a TV's power button is located on the front of PC or is integrated as a USB/HID device in the monitor or keyboard. This button should complement any user interface capability in the operating system. The OEM must comprehend the semantics for sleep capability to different power levels and the relationship of the sleep button to the main PC power switch.

Additional hard or soft programmable button implementations could include Internet access functionality, mail retrieval functionality, or other operations that need frequent convenient access.

Power budget for all devices and activities. The power supply circuitry must be dual mode. During normal operation, the capacity should be sufficient to allow full performance headroom and support for all expansion slots and connectors. Reducing slots allows smaller power capacity. During the suspended state, power delivery switches to the auxiliary mode.

The role of power-budgeting software is to match auxiliary capacity with demand during suspend state and wakeup event. Wakeup devices include on/off buttons and communication/network devices integrated on PCI, USB or other interfaces.

Easy to Expand

Integral to the flexibility of the PC is the ability to expand its hardware, software, and networking capabilities. It should be easy to add new features to the PC without compromising its prior functionality. Expansion should be via external, hot-plugged connections—such as USB—so the user does not have to open the PC case or shut down the system.

Where possible, the PC should be pre-configured for anticipated expansion. The PC should offer a suitable number of accessible connectors. Budgeting of power should be adequate to support external devices and any over-subscription of resources such as bandwidth and power should be handled gracefully. Relocating devices should not result in new discovery sequences.

Following guidelines in Chapters 4 and 7 makes it easier to set up a new PC and to later expand the PC's capabilities. Other recommended practices include:

?? Device class drivers and mappers for USB adapters should be pre-loaded when available.

?? Installs and uninstalls of drivers and applications should be complete and leave the PC registry and files in a clean state.

?? Automatic installation and configuration of driver software and all other required software, ideally without requiring any media. Driver installation should use DDK-defined standard practices.

USB Expansion

USB is the generic port for external expansion, superceding legacy connectors and preferred over internal user expansion. In addition to the bundled USB keyboard and mouse, the configuration must include 2 spare USB ports for user expansion. These ports must be clearly identified and accessible. USB ports located in the back of the chassis are convenient for network adapters and other relatively stable peripherals such as a printer or scanner. USB ports located in the front of the chassis or in the monitor or keyboard are more convenient for occasionally attached or interactive use devices.

The load image must include supported USB device class drivers and mappers to legacy adapters.

Communications and Networking

Communication to-the-home and in-the-home are essential features of an Easy PC. The system integrator may provide this capability in a variety of technology options.

The Easy PC system must integrate either high-speed internet communications or home networking. Additionally, the system must be externally upgradeable to support both capabilities.

Easy to Maintain

From the user's perspective, maintenance is an unnecessary and unrewarding chore. It is important that the PC auto-maintain what is possible and any user interaction be simple and quick. Where user action may adversely impact the machine state, the system should provide adequate safeguards and appropriately anticipate user actions. Preserving user data and application configurations should be considered. Maintenance should include updates to the BIOS and operating system. The OEM should include backup and anti-virus utilities. Overall, a well-integrated and robust system enables easy and automatic maintenance by the user.

Microsoft supports web-based service and driver updates through the Windows Update web site at http://windowsupdate.microsoft.com. Manufacturers are encouraged to participate in the testing and licensing programs provided for this web site, and to implement similar capabilities for other software components bundled with PC systems. For information about requirements for Windows Update, see http://www.microsoft.com/hwdev/desinit/digitsign.htm.

Microsoft supports web-based technical support through the Microsoft PC Health Initiative. Manufacturers are encouraged to participate in the testing and licensing programs in the operating system program, and to implement similar capabilities for other components of the PC systems.

Relevance of Legacy Removal

Specific guidelines for legacy removal are provided in Chapter 4 of this guide. This section explains the relationship of legacy removal to the Easy PC initiative.

With the evolution of the PC architecture, newer interfaces and approaches constantly provide superior methods of integrating components and devices. When industry and user benefits can be attained with newer technologies at appropriate cost points and desired functionality, the “legacy” interfaces are candidates for obsolescence. Pragmatically, the crossover occurs over time, based on user readiness and overcoming infrastructure barriers. Users who have fewest existing dependencies on legacy interfaces or devices will be earliest to adopt.

Removal of legacy interfaces presents the opportunity for simplifying and streamlining the platform, for both the hardware and the operating system. In turn, this enables a more robust, easier-to-use PC platform while allowing PC platform designers to remove much complexity and cost from their products. Increased reliability and easier maintenance translates into lower support costs. Thus, benefits accrue to both the industry and the user.

First, the industry perspective: Delivering a lower cost PC product is increasingly an OEM focus. With the benefit of ongoing silicon integration of functions, the support costs increasingly becoming a higher percentage of the total product cost. It is no longer necessary to carry the additional burden of legacy I/O. Removing these connectors and associated controllers translates into lower product cost. Additionally, simplifying the interfaces behind which devices are added and removed translates into reduced support cost.

From the user perspective, newer interfaces, such as PCI and USB, provide greater flexibility to the operating system to allocate resources, dramatically reducing configuration conflicts and the need for manual intervention or system reboots. Consequently, the user is provided with the capability to add and use a greater number of device types behind a fewer variety of interfaces.

It should be emphasized that removal of legacy interfaces is only a first step. It is important to implement the newer interfaces correctly and completely, including the observance of hardware interface compliance and device class requirements, so that the simpler capabilities for dynamically adding and removing devices are delivered.

Performance improvement should be considered a secondary motivator for legacy I/O removal. Many devices, such as storage, graphics and audio, have already migrated onto the faster PCI and AGP interfaces. As a consequence, end users will perceive only residual performance benefits. For example, implementing devices on new buses may eliminate the performance drag of polling across legacy COM and LPT. Boot speed may also increase in systems that eliminate legacy code paths and implement properly designed replacement architectures.

For additional details about the rationale for and benefits from legacy removal from PC architecture, see the related web site from Intel at http://developer.intel.com/technology/easeofuse/ and from Microsoft at http://www.microsoft.com/hwdev/newpc/.

New Form Factors

Along with simplification, a related goal for the Easy PC Initiative is to encourage system designers' efforts to introduce new, innovative industrial designs, including designs that present smaller footprints. The PC 2001 guidelines do not contain guidelines for designs based on one or more form factors. On the other hand, by limiting internal expansion to manufacturing customization versus end-user upgrade, system designers will be able to pursue alternative design options that deliver the benefits of higher functional integration.

CHAPTER 3

PC 2001 Initiatives

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 10:34 AM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Note to Reviewers: This material is still under development for incorporation into the version 0.7 draft of this guide.

CHAPTER 4

PC 2001 Core System Guidelines

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 6:28 PM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter summarizes the basic features required for all PC 2001 systems.

For definitions of common terms, acronyms, and abbreviations used in this guide, see the Glossary; see also "Conventions Used in This Guide" in "Welcome."

PC 2001 General System Requirements

This section presents a summary of the general system requirements and recommendations, including system board, memory, and BIOS requirements.

[3.1.] System performance meets PC 2001 minimum requirements

The performance requirements for PC 2001 systems are based on the minimum computational capabilities and performance necessary to support the demands of Windows-based applications together with the estimated processing demand and processing capability of the lowest-end processor in mid-2001.

The minimum performance requirement consists of the following:

?? **[3.1.1.] System includes CPU and ~~L2~~ cache that meets PC 2001 minimum requirements.** The minimum microprocessor capability is specified to support the demands of rich media, Internet access, and conferencing. The performance requirement for media enhancement is specified to ensure that the system meets performance targets at minimum platform power.

~~This processor requirement does not specify a particular processor form factor or package type.~~ The processor requirements are:

?? Minimum 500 MHz processor

?? Minimum 128KB of cache, present and enabled

~~? Desktop PC: 300 MHz Intel Architecture compatible processor with 128K Level 2 (L2) cache~~

~~? Mobile PC: 233 MHz Intel Architecture compatible processor with 128K L2 cache~~

~~? Workstation PC: 400 MHz or greater Intel Architecture compatible processor with 256K L2 cache per processor~~

Note to Reviewers: Please comment on the minimum baseline you believe will apply for the 2001 timeframe. In this 0.5 draft, these requirements are in the platform-specific chapters for mobile, desktop, and workstation.

~~This processor requirement does not specify a particular processor form factor or package type. Alpha architecture implementations that meet or exceed these performance requirements are also acceptable for systems that run Windows 2000.~~

?? **[3.1.2] System memory meets PC 2001 minimum requirements.**

Note to Reviewers: In this 0.5 draft, these requirements are in the platform-specific chapters for mobile, desktop, and workstation.

?? 64MB RAM minimum. For computers that have Windows 2000 preinstalled, 128MB RAM minimum.

~~? Desktop and Mobile: 64 MB required~~

~~? Workstation PC and Easy PC: 128 MB RAM~~

For ~~all~~ systems with 64MB RAM, a minimum of 60~~28~~ MB of memory must be available for the system to use at boot time. These minimum RAM requirements do not preclude applications that use dynamically allocated memory for audio or video playback or other temporary uses.

?? **[3.1.3] APIC implemented and properly connected ~~support, is present, is clocked and wired~~**

All desktop systems are required to have an APIC properly clocked and wired. If systems have multiple APICs, they must all be properly clocked and wired. This is so that the system can be configured either in APIC mode or in standard PIC (virtual wire) mode. Both modes must be supported for system to boot properly. Specifically, the MPIC table, revision 1.x, must be supplied by the BIOS, the 8259 PIC must be enabled, and I/O APICs set up for virtual wire mode operation.

Mobile systems that do not have APIC present are excluded from this implementation requirement.

~~**Note:** All requirements in this guide for Alpha architecture apply to the Windows 2000 operating system only. There are no plans to enable Windows to run on Alpha architecture.~~

Mobile PC Note

For complete performance guidelines and exceptions for workstation and mobile PCs, see Chapter X, “Workstation PC 2001,” and Chapter X, “Mobile PC 2001.”

[3.2] System design meets ACPI 1.0b specification and PC 2001 requirements

NOTE TO REVIEWERS: ACPI requirements in PC 2001 will be based on ACPI 1.0a, plus future ACPI revisions, as defined and accepted in 1999.

The system board must support *Advanced Configuration and Power Interface Specification, Revision* 1.0b or later. This requirement ensures that the system correctly supports Plug and Play and power management.

ACPI support must include the following:

?? **[3.2.1] System includes power management timer, button, and alarm.** The system must include a power-management timer and Power button in compliance with the ACPI 1.0b specification. This button should be implemented as described in requirement 3.3, “Hardware design supports

OnNow and Instantly Available PC initiatives." A separate reset switch is an acceptable alternative to the ACPI-specified override mechanism.

The real-time clock alarm must support wake-up at a scheduled time and day of the month. Notice that the day-of-month feature is a requirement, although it is an optional feature in the ACPI 1.0b specification.

The system must also provide a system control interrupt and Status and Enable (STS/EN) bits for the power-management timer, power button, and real-time clock.

[3.2.2] System supports S3, S4, and S5 states. The system must support the S5 (soft-off) state, as required in the ACPI 1.0b specification or later version, plus S3 and S4. Support of S1, S2, and S4BIOS is optional. ~~**System supports S5 state**The system must support the S5 (soft-off) state, as required in the ACPI 1.0a specification or later, plus S3 and either S1, S2 S3 sleep state, meaning Suspend To RAM, must be supported to provide the optimal user experience and power savings.~~

?? **[3.2.3] System includes a description table for system-board devices and ACPI control methods for configuring buses and devices.** The description table for system-board devices (including host PCI bridges) defines the complete hierarchy, including all non-Plug and Play devices to be enumerated and all other devices for which power management or removal capabilities have been added in the system-board design.

The system must include ACPI control methods necessary for configuring each bus and device enumerated using ACPI, as described in guideline [3.12], "Each bus and device meets Plug and Play specifications."

?? **[3.2.4] Devices that support wake up support D3cold.**

Support for D3cold wakeup ensures that the device can wake the system from the S3 state and any higher power sleep states the system might support.

Mobile PC Note

Mobile PCs are not required to comply with this D3cold wakeup requirement.

?? **[3.2.5] System provides no user-accessible method for disabling ACPI in the BIOS.**

If the system includes a BIOS setting that the manufacturer can use to switch between ACPI and APM modes, this setting must not be exposed to the end user in a CMOS setting or other means once a Microsoft ACPI-enabled operating system has been installed. Disabling ACPI will cause boot failures, because Windows 2000 relies on it for identification and initialization of system devices. Not having an option to "disable" ACPI support does not impact the ability to properly load an operating system that is not ACPI compatible.

~~The following power management features are recommended for all PC 2001 systems:~~

?? **[NEW 3.2.6] If system includes a fan, ACPI thermal model and fan control is implemented.** A thermal model and fan control must be implemented as defined in Section 12 of the ACPI 1.0b specification as a means of running the PC quietly while it is working and turning the fan off while it is sleeping.

~~Notice that a hardware-based, open-loop thermal control is an acceptable implementation for system cooling if it meets requirement [3.7], "Audible noise meets PC 2001 requirements." However, the recommended implementation is a closed-loop control using the PC's processor, an embedded controller, or both. If a closed-loop implementation is used, it must comply with the ACPI 1.0a specification or later.~~

~~**BIOS must support standard options for automatic restart in the event of system power loss.** BIOS must have a setup option that allows users to select the desired restart behavior of the PC after a system power loss. Systems should provide three standard restart options:~~

~~1) Always restart~~

~~2) Remain off~~

~~3) Return to the same state (either off or on) as before power loss~~

~~The third option (return to last state) should be set as the system default.~~

~~If this restart selection feature is supported, it must be implemented as an OEM extension using ACPI control methods to facilitate future standardization and enhanced support in the Microsoft Windows family of operating systems such as a standard application programming interface (API).~~

~~Also, in addition to any user interface provided by a BIOS setup program, a user interface to select the restart option must be implemented as a property page extension to the Windows Power Management control panel.~~

Note: Any other system-board power management or Plug and Play features must be implemented in compliance with the ACPI 1.0b or later specification, even if a particular feature is not a specific requirement or recommendation.

[3.3.] Hardware design supports OnNow and Instantly Available PC initiatives

Elements of the Instantly Available and OnNow design initiatives ensure that the operating system and device drivers control the state of individual devices and the system board. The Instantly Available PC initiative is fully consistent with the OnNow design initiative and provides guidelines for hardware design to ensure efficient power management on the desktop.

These initiatives are based on these goals for the user experience:

?? The user experiences the PC as off when it is in a sleep state

?? The user can easily see whether the PC is working or sleeping

?? The user can easily control power through switches and software

Based on these goals, the following is required to support the OnNow and Instantly Available PC initiatives:

?? **[3.3.1] System and devices appear as off in the sleep state.** At a minimum, all media drives, display, sound, input devices, and fans must be perceived as off when the system has completed the transition to a sleep state, for example, no noise or lights other than the status indicator. It is acceptable for system fans to run for some period of time, provided these automatically turn off once sufficient cooling is achieved at normal room temperatures (78 degrees Fahrenheit and below), and the system is then not perceptibly louder than in the off state.

?? **[3.3.2] System provides one or more indicators to show whether the system is in the working or sleep state.**

This requirement applies for S1, S2, and S3 system states.

An indicator must~~should~~ be a non-flashing, light-emitting ~~diode (LED)~~ sleep indicator that is a different color than the wake indicator. A slowly blinking LED indicator (less than 1 Hz) is also an acceptable implementation.

The nonvolatile sleep state, S4 or S4BIOS, ~~should~~ must appear to the user as the off state (S5); therefore, all of these states ~~should~~ must have the same indicator.

If telephone answering machine capabilities are built into the system, ~~then~~ a Message Waiting indicator ~~should~~ must be included on desktop systems.

?? **[3.3.3] System provides software-controlled, ACPI-based power switch.** The system must provide an easily accessible power switch that can be controlled by software. ~~and that supports the functionality required in Section 4.7.2.2.1 of the ACPI 1.0x.x specification.~~ This requirement for an easily accessible power switch does not preclude power-control capabilities, such as closing the lid on a mobile PC.

The following provides implementation guidelines for the power switch:

?? A single ACPI button design is preferred. This button must be the user's primary switch interface, and must be implemented as a power button as defined by the ACPI 1.0b specification.

?? If a two ACPI button design is used, the sleep button must be the user's primary switch interface, and be easily distinguishable from the power button. The preferred implementation in a two button design is to hide the power button behind a door or on the rear of the system.

?? The function of these buttons is determined by the operating system.

?? In case of a hardware or software failure that prevents normal operation of the software-controlled buttons, the switch capabilities must include an override mechanism for turning off the PC.

A four-second override mechanism is recommended in Section 4.7.2.2.1 of the ACPI 1.0b or later specification. The override must be associated

with the user's primary switch interface, in order to establish an industry-standard implementation.

Notice that the override mechanism is not an alternative way for the user to turn off the PC in normal operation; it is only a fail-safe function for fault conditions.

?? If the power switch is provided on the keyboard, the key must be clearly labeled and must consist of a single keystroke for turning on the PC, to ensure accessibility for persons with disabilities. (Two keystrokes can be used to turn off the PC.) For information about scan codes for keyboard power switches, see the information available on the web site at http://www.microsoft.com/hwdev/desinit/scancode.htm.

Note to Reviewers: The implementation guidelines above are expected to move to a separate doc at 0.7 time frame. This is consistent with goal of reducing size by 50%.

~~? The power switch can be implemented as either a power button or a sleep button. It is recommended to Implementing both buttons for desktop and mobile PCs is encouraged. If both buttons are implemented, the sleep button should be the user's primary switch interface and must be easily distinguishable from the power button. The preferred implementation is to hide the power button.~~

~~? The function of these buttons is determined by the operating system. The default action for the sleep button is to cause the machine to enter a sleep state. The default action for the power button is to shut down the operating system and power off the machine.~~

~~In a single-button configuration, the button can be used for either sleep/wake transitions (G0< >G1/S1-S4) or off/on transitions (G0< >G2/S5), depending on user preference and the policy set in the operating system.~~

~~In a two-button configuration that includes separate power and sleep buttons, the user interface provided by the operating system will allow only the default actions.~~

~~? In case of a hardware or software failure that prevents normal operation of the software-controlled buttons, the switch capabilities must include an override mechanism for turning off the PC.~~

~~A 4-second override mechanism is recommended in Section 4.7.2.2.1 of the ACPI 1.0a~~x.x or later specification. ~~The override can be on either the power button or the sleep button in a two-button configuration, but it is recommended that the override~~ should ~~be associated with the sleep button in order to establish an industry-standard implementation.~~

~~An acceptable but not recommended~~ encouraged ~~alternative to the 4-second override is a separate hidden or recessed switch that cannot be mistaken for either the power button or the sleep button.~~

Notice that the override mechanism is not an alternative way for the user to turn off the PC in normal operation; it is only a fail-safe function for fault conditions.

? If the power switch is provided on the keyboard, the key must be clearly labeled and must consist of a single keystroke for turning on the PC, to ensure accessibility for persons with disabilities. (Two keystrokes can be used to turn off the PC.) For information about scan codes for keyboard power switches, see the information available on the web site at http://www.microsoft.com/hwdev/desinit/scancode.htm.

?? **[3.3.4] Each device supports the power management specifications for its class.** All devices and drivers must support the D0 and D3cold power states consistent with the definitions in the relevant device class power management reference specification and the *Default Device Class Power Management Specification, Version 1.0* or later. Support of D1 and D2 states is optional, unless stated as required in the relevant device class specification.

Therefore, each device can successfully survive a system sleep/wake transition (where the device transitions from D0 to D3cold to D0) without losing functionality and without requiring user intervention to restore functionality. This requirement applies whether or not system power is removed while the device is in the D3 power state.

There is no power consumption requirement for devices in the D3 power state. However, devices should implement the D3 power state such that device power consumption is reduced to near zero.

This guideline includes no requirement to retain any device context because it will be preserved or restored by the driver when returning to the D0 power state.

PCI, USB, IEEE 1394, and PC Card buses must support power management requirements as defined in their related bus standards. For information, see the respective chapters in Part 3 of this guide.

?? **[3.3.5] System power supply provides "standby" power for system wake-up events.** A minimum of 720mA of "standby" currentpower at 5V is required to support wake-up devices on PCI or USB when the system is in the ACPI S3 or , S4, or S5 state.

All PC 2001 systems must support a power delivery system that supports both normal operation and system wake-up events. During normal operation, the capacity must be sufficient to allow full performance headroom and power support for all PCI slots. During the suspended state, the power delivery system switches to the auxiliary mode, which allows for the maintenance of system state and keeps the resume capacity functional.

The system must provide power-budgeting software that must comprehend auxiliary power supply capacity in the system and allow a variable number of wakeup devices to be supported. Wakeup devices could include and are not limited to: front panel on/off button, USB-based keyboard and monitor,

~~AMR/PCI/USB-based modem controller, PCI or motherboard-based LAN controller, and so forth.~~

For more information, see the Instantly Available PC System Power Delivery Requirements and Recommendations available from the web site at http://developer.intel.com/design/power/supply98.htm.

Mobile PC Note This requirement for the system power supply does not apply to mobile PCs.

PC 2001 BIOS Requirements

This section states requirements for the basic input/output system (BIOS). Remote boot is separate from general BIOS requirements to discriminate between corporate platforms, where they most often apply, and other desktop or mobile computers.

For BIOS requirements related to legacy-free designs, see also "PC 2001 Legacy Free Requirements" later in this chapter.

[3.4.] BIOS meets PC 2001 requirements for OnNow/Instantly Available PC support

~~This requirement does not apply for Alpha architecture, except for the requirement for fast power-on self-test (POST).~~

The intention of this requirement is to ensure that the end user is not presented with confusing information and unnecessary visual display, and to ensure that access to error information remains available using a hot key.

ACPI BIOS entries, as defined in Section 1.6 of the ACPI 1.0b specification, must be the same for supporting either Windows 98 or Windows 2000.

In addition to the PC 2001 requirement to support S4, the following BIOS capabilities are required for OnNow support:

?? **[3.4.1] BIOS supports Fast POST.** Power on to the bootstrap loader handoff must occur in 7 seconds or less for non-SCSI systems, 10 seconds or less for SCSI systems. This time limit includes, if present, initialization of keyboard, graphics adapter, SCSI, and primary storage bus. This time limit does not include hard disk spin up time, additional option ROMs, user PXE boot option, and time required for error correction code (ECC) scrubbing, if supported and enabled. ~~The system must be available to the user as quickly as possible. The requirement is that power-on to the bootstrap loader handoff occurs in 7 seconds or less, plus hard disk ready time, option ROMs, and time required for error correction code (ECC) scrubbing~~.

?? **[3.4.2] Resume from sleep state (S1–~~S4~~S3) to operating system handoff occurs within 500 ms.** This requirement does not apply for the S4~~BIOS~~ state. For ~~all other~~ sleep states S1, S2, and S3, the time to operating system handoff is measured from when the processor starts running (first instruction) ~~until~~ to

the time that the BIOS jumps to the Waking Vector in the ACPI firmware control structure table, as described in Section 5.2.6 in the ACPI 1.0b ~~1.0~~ specification.

?? **[3.4.3] System presents minimal start-up display.** System start-up must only draw the end user's attention in case of errors or when there is a need for user action. By default, the system must be configured so the screen display does not display memory counts, device status, and so on, but instead presents a "clean" BIOS start-up, allowing a manufacturer's branding message and hot-key or end user action notices.

[NEW.3.101] BIOS supports remote boot

All systems that are designed for use with Windows 2000 must meet these requirements.

These requirements do not apply to Mobile PC systems that do not include either a LAN on motherboard network interface or a pre-installed mini-PCI LAN adapter.

The BIOS remote boot support requirements include the following:

?? **[3.5.1] BIOS supports Preboot Execution Environment (PXE).** ~~**BIOS supports preboot execution environment, with unique system ID provided in print.**~~ The system must support remote boot as defined in Preboot Execution Environment (PXE) Specification, Version 2.1 available at http://developer.intel.com/ial/wfm/wfmspecs.htm. ~~For Desktop PCs, the system's execution environment must conform to the description given in "Attachment B: Preboot Execution Environment" of *Network PC System Design Guidelines*~~

~~For desktop and workstation systems, this requirement means providing a unique PXENV system identifier (ID) structure in the system BIOS or CMOS, as defined in "Attachment B: Preboot Execution Environment" of *Network PC System Design Guidelines.*~~

?? **[3.5.3] BIOS supports booting the system from the network and using F12 to force a system boot.** The system BIOS must comply with the requirements defined in Sections 3 and 4, as they apply to Plug and Play devices, of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*, which describes the requirements for Initial Program Load (IPL) devices.

The system must also allow all boot devices to be configured as to order of precedence for boot. This mechanism must clearly show how the system will order boot devices when end users are making configuration choices. For example, in a system that permits booting from floppy drive, hard drive, CD, ~~or~~ DVD drive, ~~and~~ or network adapter, it must be clear to the end user how to set a boot order that favors a specific device, such as the network adapter.

In addition, for any system that includes a network adapter, ~~sequence must be providedto invoke a pop-up screen that allows the user to~~ the F12 key must force a system boot initiated from the network adapter. This key ~~sequence~~ function must be enabled by default. Configuration of this feature can be provided through a ~~CMOS~~ BIOS configuration setting. When this feature is enabled, the boot display must indicate that F12 will invoke a network boot.~~e key sequence that will invoke the pop-up screen that would allow a network boot.~~ This display must appear for a duration sufficient to be read by users, but must not lengthen the overall time needed to boot the machine.

This feature must be implemented in accordance with Appendix C of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. This feature is a PC 2001 requirement, although it is optional in the *BIOS Boot Specification*.

Systems that already utilize the F12 key for another OEM-defined BIOS function, or do not have an F12 key, may use an alternate key for network boot.

~~For a consistent user experience across all system brands and types, it is suggested that system and BIOS manufacturers standardize on the F12 key to perform this action. It is expected that F12 or another standard key sequence will become a requirement in future versions of the design guidelines.~~

?? **[NEW.3.5.1x] The system universal unique ID (UUID) is provided in print.** The system universal unique ID (UUID) must be provided to the user in printed form on the outside of the system chassis or case at a minimum, for assistance in environments where it might be used as part of pre-staging systems.

~~In addition, for systems, the unique system ID must be provided to the user in printed form, for assistance in environments where it might be used as part of pre-staging systems. This mechanism is left up to the system manufacturer, but suggested means include posting the unique system ID on the system chassis or case, or printing it on the shipping carton.~~

~~*Mobile PC Note*~~ ~~Only mobile PCs that ship with an integrated network adapter are required to provide the unique system ID in printed form. Initially, the unique system ID will be used for creating a Machine Account Object for the remote installation service. Currently, no Microsoft operating system supports remote installation using a PC Card network adapter.~~

?? **[NEW.3.101.1] BIOS supports Boot Integrity Services (BIS).**

For systems that include integrity or authentication services for downloaded remote boot images, the system's BIOS must provide these capabilities as defined in *Boot Integrity Services (BIS)*, Version 1.0 available at http://developer.intel.com/ial/wfm/wfmspecs.htm.

In addition to the management data required by SMBIOS 2.3, BIS requires inclusion of Type 31 (BIS Entry Point) in the table of exported SMBIOS structures.

Structure Name and Type	Data Requirements
Boot Integrity Services Entry Point (Type 31)	Both 16-bit real-mode and 32-bit flat protected-mode entry points are non-zero. The overall structure checksum evaluates to zero

?? **[NEW.3.101.2] System BIOS provides remote lockout capability.**

During remote management of a PXE client, it may be required to prevent an end-user from interrupting sensitive operations like a BIOS update. The Remote Lockout Interface (RLI) allows programmatic lockout of events that could interrupt such an operation. The interface is expected to be used by software executing on the client system.

The RLI hides the details of the underlying hardware implementation. This allows manufacturers to provide different lockout hardware implementations while providing a consistent control interface to system software.

Initial Conditions: The initial state of the Remote Lockout setting after power-on, cold boot or warm boot is all events are enabled. Management software uses this interface to lockout events. Management software should re-enable events when sensitive operations have been completed.

Invocation and Parameter Passing: The Remote Lockout Interface is only available in real mode and is invoked using INT 15H. All parameters are passed to and from the RLI functions using processor registers. The AH register is set to 25H for the RLI and the AL register indicates the desired RLI function.

The AX, BX CX, DX, SI and DI registers may be altered by the RLI. Management software should save these registers before calling RLI functions and restore them on return (after retrieving any parameters returned by the RLI). All other processor registers are preserved.

If the function is successful, the RLI returns with the CF (carry flag) reset and the AH register set to zero.

If an error is encountered, the RLI functions return with the CF (carry flag) set and AH set to one of the following return codes:

86h—ERR_FUNCTION_NOT_SUPPORTED

The Remote Lockout Interface (RLI) supports three functions:

?? Inquire Lockout Capabilities

?? Get Remote Lockouts

?? Set Remote Lockouts

All of the RLI functions use a bitmap to describe lockouts. Inquire Lockout Capabilities and Get Remote Lockouts return this bitmap. Set Remote Lockout uses this bitmap to select events to lockout. The bits are numbered from zero to 15 with the right-most bit being the least significant and bit 0. The Lockout Bitmap is defined as follows:

Bit	Definition
0	Permanently reserved, was hard on/off switch for pre-v1.1 implementations of this interface.
1	Soft On/Off Switch (controlled via ACPI power-button interfaces)
2	Reset button
3	Mouse
4	Ctrl-Alt-Del key combination
5	All keyboard activity (if all keyboard activity is disabled, the Ctrl-Alt-Del key combination is also disabled, regardless of the setting of Bit 4.
15 .. 6	Reserved for future use (reset to zero for backward and forward compatibility)

Note to Reviewers: The following text deviates from our usual level of detail. At this time, we have no mutually drafted whitepaper, spec, or web page to reference. By the release of SDG draft 0.7, this information will be provided in another location, possibly an appendix.

Inquire Lockout Capabilities (00H): This function returns the lockout capabilities of the system. The bit-mapped value returned in the CX register indicates the lockouts managed by the RLI. All return values are static. This function always returns the same values. The current lockout setting does not affect the value returned by this function.

Input [AX] = 2500H

Output
[CF] = status
Set = error
Reset = success
[AH] = Return code, if CF set
86h ERR_FUNCTION_NOT_SUPPORTED
If [CF] reset,
[AH] = Zero (00)
[BX] = Revision (BCD-encoded with an implied decimal point between the bytes. For example, 0110H is 1.10)
[CX] = Lockout capabilities
(see Lockout Bitmap definition above)
If bit set, event lockout supported
If bit reset, event lockout not supported

Example
```
MOV AX, 2500H ; Inquire Lockout Capability
MOV BX, 0 ; Clear output registers
MOV CX, 0
INT 15H ; Able to get capabilities?
JC ERROR ; No, error out
MOV wRevision, BX ; Yes, save interface revision
MOV wCapabilities, CX ; and system lockout capabilities
```

Comments This function was unintentionally omitted from versions of the RLI prior to Version 1.1.

Get Remote Lockouts (01H): This function returns the current lockout setting. The bit-mapped value returned in the CX register indicates which events are enabled and which events are locked out.

Input [AX] = 2501H

Output
[CF] = status
Set = error
Reset = success
[AH] = Return code, if CF set
86h ERR_FUNCTION_NOT_SUPPORTED
If [CF] reset,
[AH] = Zero (00)
[CX] = Current lockout setting for all supported events
(see Lockout Bitmap definition above)
If bit set, event locked out
If bit reset, event enabled (or unsupported)

Example

```
MOV  AX, 2501H        ; Get Remote Lockouts
MOV  CX, 0            ; Clear output registers
INT   15H             ; Able to get remote lockouts?
JC ERROR        ; No, error out

MOV  wInitialSetting, CX  ; Save initial setting

TEST  CX, 4           ; Is Reset event locked out?
JZ  RESET  ENABLED  ; No, continue
                      ; Yes
```

Comments Only supported events are reported. Attempts to lockout unsupported events are not reflected in the Lockout Bitmap returned by this function. Only bits for supported events are ever set in the Lockout Bitmap.

Set Remote Lockouts (02H): This function locks out or enables the specified events. The bit-mapped value passed in the CX register indicates which events to allow and which events to lock out.

Input
[AX] = 2502H
[CX] = Desired lockout setting (see Lockout Bitmap definition above)
If bit set, requesting event be locked out
If bit reset, requesting event be enabled

Output
[CF] = status
Set = error
Reset = success
[AH] = Return code, if CF set
86h ERR_FUNCTION_NOT_SUPPORTED

If [CF] reset,
[AH] = Zero (00)

Example

```
MOV  AX, 2502H        ; Set Remote Lockouts
MOV  CX, 2       ; Disable Soft On/Off events, enable all others
INT   15H             ; Able to set remote lockouts
JC ERROR        ; No, error out
```

Comments If supported, this request always succeeds. Requesting lockout of an unsupported event is not an error. The interface simply ignores the request for that event and sets supported events as requested (locked out or enabled).

[3.5.] BIOS ~~meets PC 2001 requirements for~~ includes local boot support

The BIOS boot support requirements include the following:

?? **[3.5.2] BIOS supports booting the system from a CD or DVD device.** For any system that includes a CD drive or DVD drive, the system BIOS or option ROM must support the No Emulation mode in *El Torito—Bootable CD-ROM*

Format Specification, Version 1.0, by IBM and Phoenix Technologies, Limited, or an equivalent method that supports the process for installing Windows from compact disc.

?? **[3.5.7] BIOS provides boot support for USB keyboards and hubs.** ~~For systems based on Intel Architecture compatible processors, t~~The system BIOS must provide boot support for USB keyboards and hubs as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* ~~or later~~. This support must provide the ability for the user to enter the system's BIOS setup program and provide enough functionality to get a USB-aware operating system installed and booted.

?? **[3.49.] Operating system recognizes the boot drive in a multiple-drive system.** The BIOS must comply with the implementation of boot-drive determination in multiple-drive systems, as defined in Section 5.0 of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. Both Windows 98 and Windows 2000 operating systems use this format for determining the boot drive when new bootable devices are introduced to a PC. The system designer can use an equivalent method for boot-drive determination but the method must ensure that the Windows 98 and Windows 2000 operating systems recognize the boot drive.

~~Mobile PCs, which have built-in keyboards, are exempt from this requirement for BIOS support of USB keyboards.~~

?? **[NEW.3.106.2] Timer is supported at system boot.** The ROM BIOS must make sure that the timer is on at system boot and that timer interrupts are occurring as part of POST or RESET.

[3.55.] BIOS supports SMBIOS 2.3

Windows 2000 can present SMBIOS 2.2 or later static table data in ~~WBEM~~WMI. System designers must provide platform-specific static information at boot time using this mechanism~~s~~. For more information about SMBIOS, see *System Management BIOS Reference Specification, Version 2.3*.

~~SMBIOS static table support is likely to become a requirement in future versions of these guidelines.~~

[3.5.4] BIOS properly accommodates all dates

BIOS and CMOS ~~hard~~firmware support calendar ~~D~~dates~~, including the year 2000 and beyond, correctly supported in BIOS and CMOS~~.

[3.5.5] BIOS ~~on Office PC~~ supports security

All ~~Office~~ PC systems must provide some mechanism for security, such as a pre-boot password, to protect enable/disable capabilities for hardware components before the operating system boots.

~~This capability is also recommended for other system types. The purpose of this feature is to prevent end users from accidentally or purposefully circumventing operating system level security and control as applied by an administrator.~~

[3.5.6] BIOS supports BIOS updates and revisions

Capability for BIOS updates must be provided~~implemented in order for BIOS ROMs to be upgraded to a new image through OEM-provided programs~~. The following methods can be used to meet this requirement:

?? Through a remote new system setup mechanism downloaded and executed at boot time as described in Chapter X, "Network Communications"

?? Through a normal file access and execution methods when the system is fully booted into the normal operating system environment

If option ROMs are provided, they must also be capable of being upgraded.

[3.5.8] System BIOS supports ~~console redirection of a serial port~~debug port

BIOS provides support for system debug port. The debug port can be used during system startup for debugging, troubleshooting, and software development.

If a legacy serial port is implemented, the BIOS must provide an option to configure at least one legacy serial port to use either 2F8h or 3F8h. This capability allows the port to be treated as a boot device by the BIOS and is required to be usable by components as a diagnostic port in the event that system debugging is required by either the BIOS or the operating system.

For a legacy-free system, the implementation must meet the requirements defined in guideline [NEW.3.110] "System supports PC2001 legacy-free debug capabilities."

Note to Reviewers: A citation for a Debug Port specification will be available in a future draft.

~~**? If the system includes an ATAPI bootable drive, BIOS supports boot.**~~

~~System BIOS or option ROM provides boot support for primary ATAPI bootable floppy disk drive in compliance with *ATAPI Removable Media BIOS Specification (ARMD), Version 1.0* or later. Complying with this specification provides Int 13h and Int 40h support for bootable floppy drives as the primary or secondary floppy device.~~

[3.45.] System BIOS and option ROMs support Int 13h Extensions

BIOS and option ROMs support Int 13h Extensions as defined in the "Layered Block Device Drivers" section of the Windows 98 DDK. ~~This requirement applies for systems that run either Windows 98 or Windows 2000, but does not apply for Alpha architecture.~~ This requirement also applies for RAID controllers when implemented.

Additional BIOS requirements to support legacy reduction are defined in "PC 2001 Legacy Reduction Requirements" later in this chapter.

[NEW.3.112] ROM BIOS interrupt handlers preserve values in all registers

ROM BIOS hardware interrupt handlers must preserve the values in all registers, including the high 16-bits of 32-bit registers. ROM BIOS API handlers must preserve the values in all registers, including the high 16-bits of 32-bit registers that the API is not documented to modify.

Any ROM BIOS API that is documented to modify only the low 16-bits of a 32-bit register must preserve the high 16-bits of that 32-bit register, because this is least likely to cause compatibility problems for applications that use that API.

If a ROM BIOS API is documented to modify the flags—for example, it is documented to return with the CARRY flag set or cleared—this restriction does not apply to individual arithmetic bits in the flags register. Any ROM BIOS API that is documented to modify the flags is assumed to modify all of the "arithmetic" flag bits: AUX-CARRY, CARRY, OVERFLOW, PARITY, and ZEROSIGN

The values of the other bits in the flags register must be preserved unless the API is documented to modify them.

The BIOS supports specific MS-DOS interrupts. The list in Appendix A, "Resource Mapping," shows the known BIOS dependencies for which support will be required. Unless otherwise stated, all subfunctions must be present on a legacy free PC 2001 system.

PC 2001 Physical Design Requirements

This section summarizes physical design requirements and recommendations for PC 2001 systems. These requirements are in addition to those related to the OnNow and Instantly Available PC initiatives for power-state indicators and easily accessible power switches.

~~**3.6. [DELETE] All expansion slots in the system are accessible for users to insert cards**~~

[3.7.] Audible noise meets PC 2001 requirements

A PC 2001 system must be "silent" in any sleep state. That is, it must be perceived as not significantly noisier than the off state to typical users, relevant to an operating position appropriate to the PC's form factor (such as desktop, minitower, or laptop) and the ambient noise level of its normal usage environment (such as corporate office, home office, family room, and so on). This requirement applies primarily to fan noise, as all other devices will not be active in the sleep state.

~~It is hoped that this definition will become more objective over time through standardization of acoustic noise measurement and reporting procedures for PCs. Intel and Microsoft are working on proposals for acoustic noise measurement and reporting. The goal is to achieve common PC acoustic noise measurement methods based on established international standards. With such methods in place, end users will be able to receive reliable acoustic noise specifications about PCs similar to those available for other product categories such as automobiles and appliances.~~

The goal is to achieve quieter PCs based on established international standards through acoustic noise measurement and reporting procedures. Intel and Microsoft are working on proposals for acoustic noise measurement and reporting.

Although this requirement does not specify noise limits for PCs in idle and working states, manufacturers are encouraged to design systems that operate as quietly as possible, especially PCs designed for use in the home family room.

[3.8.] System and component design practices follow accessibility guidelines

At a minimum, the OEM must:

?? Ensure that the keyboard and other input devices work correctly with the Microsoft Accessibility features in Windows. For example, Sticky Keys must work with all keys in any keyboard design.

?? **TBD**: ~~Meet the i~~International design requirements that must be met under new legal guidelines for accessibility~~, such as those being published by the U.S. government.~~

?? Make all modifier keys capable of being read and operated by software, including F*n* and similar OEM-specific keys. This capability allows users to access these keys and the functions that rely on them through operating system features, such as StickyKeys and SerialKeys, and through third-party software such as voice recognition.

~~**3.9. [DELETE] Internal system modification capabilities are not accessible to end users**~~

~~**3.10. [DELETE] System design provides physical security**~~

PC 2001 System Expansion Buses

[3.25.] PC 2001 system includes USB with 2 user accessible USB ports, minimum

USB must meet the requirements defined in Chapter X, "Buses and Interfaces." System includes two user accessible USB ports in addition to any used by the keyboard and pointing devices.

Mobile Note

For guidelines to any implementation of USB on mobile PCs, see Chapter 6, “Mobile.”

[3.26.] If IEEE 1394 is implemented, ~~System includes support for IEEE 1394~~all components meet PC 2001 guidelines

If IEEE 1394 is implemented in a system, it must meet the requirements defined in Chapter 8, "Buses and Interfaces." System must provide two externally accessible IEEE 1394 socket connectors, at minimum.

~~It is recommended that all systems have at least one IEEE 1394 port for external expansion devices, such as scanners and external drives. If implemented, the ports must be compliant with IEEE P1394.a and OHCI Version 1.0, as described in Chapter 8, “IEEE 1394.”~~

~~**Note:** Implementation of IEEE 1394 is likely to become a requirement for desktop systems in future versions of these design guidelines.~~

Mobile PC Note

For guidelines to any implementation of IEEE 1394 on mobile PCs, see Chapter 6, “Mobile.”

[NEW.3.103] If SCSI is implemented, all components meet PC 2001 guidelines

If SCSI is implemented in a system, it must meet the requirements in Chapter 8, "Buses and Interfaces."

[NEW.3.104] If ATA/ATAPI is implemented, all components meet PC 2001 guidelines

If ATA or ATAPI are implemented in a system, they must meet the requirements defined in Chapter 8, "Buses and Interfaces."

[3.27.] If PCI is implemented, ~~present, PCI bus meets PCI 2.1 or later, plus PC 2001 requirements~~ all components meet PC 2001 guidelines

If PCI is implemented in a system, it must meet the requirements defined in Chapter 8, “Buses and Interfaces.”

PC 2001 General Device Requirements

The requirements in this section apply for every device, whether present on the system board or as an expansion device provided by the OEM in a default system configuration. Most general device requirements are related to Plug and Play capabilities.

[3.11.] Each device and driver meets PC 2001 device requirements

Each device must comply with all requirements defined in this guide for the related device class, whether the device is provided in the PC system as an expansion card or as an external device.

Drivers must be provided for both Windows 98 and Windows 2000 operating systems.

In addition to the device requirements in this section, see also the specific requirements for each device class in this guide.

[3.12.] Each bus and device meets Plug and Play specifications

Each bus and device provided in a PC 2001 system must meet the current Plug and Play specifications related to its class, including requirements defined in Section 6 of the ACPI 1.0b ~~1.0~~ specification and clarifications published for some Plug and Play specifications. This guideline includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities.

Any legacy components remaining in a legacy-reduced system must meet the requirements defined in *Legacy Plug and Play Guidelines* (available at http://www.pcdesguide.org/LegacyPnP/), which contains all the requirements for legacy Plug and Play, as published in *PC 99 System Design Guide.*

For information about Plug and Play support under Windows 2000, see the Windows 2000 Driver Development Kit (DDK).

The following list shows current version numbers for all Plug and Play specifications:

?? *PCI Local Bus Specification, Revision ~~2.1~~2.2*

?? *Plug and Play External COM Device Specification, Version 1.0*

?? *Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a*, and *Clarification to Plug and Play ISA Specification, Version 1.0a*

?? *Plug and Play Parallel Port Device Specification, Version 1.0b*

?? *Plug and Play Small Computer System Interface Specification, Version 1.0*

?? *USB Specification, Version 1.1*

Plug and Play specifications for IEEE 1394 are defined in this guide. For information, see Chapter X, “Buses and Interfaces.”

[3.13.] Unique Plug and Play device ID provided for each system device and add-on device

Each device connected to an expansion bus must be able to supply its own unique ID. The following are the specific requirements for Plug and Play device IDs:

?? Each separate function or device on the system board must be separately enumerated; therefore, each must provide a device ID in the manner required in the current Plug and Play specification for the bus it uses.

?? If a device on an expansion card is enumerated by the BIOS, it must have a unique ID and its own resources according to the current device ID requirements for the bus to which the card is connected. This requirement includes devices that are separately enumerated on multifunction cards or multifunction chips.

Multifunction CardBus devices must meet the requirements defined in the multifunction standards for CardBus designs defined by PCMCIA (see http://www.pc-card.com/papers/multfunc.htm). Driver implementation for Windows 2000 is defined in the Windows 2000 DDK (see the information about Mf.sys).

In addition, for ~~for Office PCs,~~systems designed for use with Windows 2000, if an OEM uses a proprietary mechanism to assign asset or serial numbers to hardware, this information must be available to the operating system using Windows hardware instrumentation technology, as defined in the *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0.*

Legacy devices attached to the ISA bus on the system board are not required to have unique Plug and Play IDs—for example, serial ports, parallel ports, or Personal System/2 (PS/2) compatible port devices. For information, see *Legacy Plug and Play Guidelines.*

Some multifunction devices, such as Super I/O, might include devices that~~do not~~ are not required to have unique Plug and Play IDs or unique PCI subsystem IDs, but that are supported by drivers provided with the Windows operating system.

~~A device such as a multifunction PCI device that supports a number of functions but uses only a single set of relocatable resources is not required to provide separate IDs for each function included on the device.~~

[3.14.] Option ROMs meet Plug and Play requirements

For implementation details, see *Legacy Plug and Play Guidelines.* Systems designed to run only on Windows 2000 are not required to meet these requirements for legacy Plug and Play support.

[3.15.] "PNP" vendor code used only to define a legacy device's Compatible ID

For implementation details, see *Legacy Plug and Play Guidelines.*

[3.16.] Device driver and installation meet PC 2001 requirements

Each device must have drivers for both Windows 98 and Windows 2000 operating systems to ensure correct support under both operating systems. For

some device classes, this support can be provided using a Windows Driver Model (WDM) driver, as defined in the related device requirements in this guide.

The manufacturer does not need to supply a driver for a device if the device passes PC 2001 compliance testing using a driver provided with the operating system. If the manufacturer does supply a driver, it must meet the requirements for device drivers and installation under Windows 98 and Windows 2000 ~~include the following.~~:

?? **[3.16.1] Driver installation does not interfere with other devices.** The installation and loading of a driver must not reduce or eliminate functionality of other devices installed on the system.

?? **[3.16.2] Devices with WDM support in Windows include WDM-based drivers.** For any device for which WDM-based support is provided in the operating system, the driver supplied by the manufacturer must be a WDM minidriver. This requirement applies whether the system comes pre-installed with Windows 98 or Windows 2000.

?? **[3.16.3] Driver supports Plug and Play and power management IRPs.** Every driver (or minidriver) must support Plug and Play and power management I/O request packets (IRPs). This requirement applies whether the system comes pre-installed with Windows 98 or Windows 2000.

For VxD drivers for Windows 98, the following requirements apply:

?? Every VxD must support Plug and Play and power management messages.

?? The driver must provide power management support as required by any related device class power management reference specification.

?? **[3.16.4] All configuration settings are stored in the registry.** The driver must not use initialization files (INI) for configuration settings.

The driver must also include correct provider, version, and copyright entries. This information is displayed in the user interface, such as Device Manager in Windows.

?? **[3.16.5] All INF and other file information is correct.** The correct minidriver, virtual device drivers (VxDs), or any other manufacturer-supplied files specified in the device's information file (INF) must be installed in the correct location.

For manufacturer-provided files, the vendor must *not* be identified as Microsoft and all other copyright and version information must be correct for the manufacturer.

Files provided by the vendor must not use the same file names as used by files included in Microsoft operating systems and provided as either retail or OEM products, unless specifically agreed upon with Microsoft.

?? **[3.16.6] Installation uses methods defined in the DDK.** Driver installation and removal must use Windows-based methods, as defined in the Windows 98 and Windows 2000 DDKs.

The device driver must be able to be removed using Windows-based software, which can be managed using either the Windows Control Panel option for removing devices or its own remove utility. For information, see the driver installation information in the \SRC\General directory in the Windows 2000 DDK; see also "Windows 95 Class Installers and Network Driver Installers" in the Windows 95 DDK.

However, any software applications included with the device can be installed using an alternate Windows-based installation method as defined in the Microsoft Platform Software Developers Kit (SDK).

Also, any software components and registry entries installed during driver installation must be removed during driver un-installation.

Any real-mode components provided for backward compatibility under Windows 98 should use separate installation procedures. Although installation of Windows-based components must not make entries in Autoexec.bat or Config.sys, the separate real-mode installation program can make such entries but must not modify the registry, Win.ini, or System.ini.

? **[3.16.7] Driver supports unattended installation.** It must be possible for the device's driver to be installed using a mechanism, such as a script or special software for supplying required parameters, without the user being present.

? **[3.16.8] Driver includes Help file if special parameters are used.** To ensure that the user can correctly change settings, a Windows Help file must be provided if special driver parameters are used. The device's installation routine must install the Help file as part of the setup program. The user interface for the device's dialog boxes must display the correct Help file, and the Help file must contain relevant information to assist the user. The guidelines for implementing a Help file are defined in the Windows 2000 DDK.

[3.17.] Minimal user interaction needed to install and configure devices

After physically installing the device, the user must not be required to perform any action other than to insert the disks that contain drivers and other files. The user should have to restart the system only for devices that do not support hot plugging.

As specified in requirement 3.19, "Hot-plugging capabilities for buses and devices meet PC 2001 requirements," devices that use USB, IEEE 1394, or PC Card must support hot-plugging. For devices that use other buses, detection occurs when the system is powered on after the device is inserted.

The following requirements must be met:

?? **[3.17.1] The device is immediately functional without restarting the system.** It is acceptable to require rebooting for primary system devices such as the primary graphics adapter and the primary hard disk controller; furthermore, ATA drives are not required to implemented Cable Select (CS)

settings. In all cases, however, changing configuration settings must not require the end user to make jumper changes.

?? **[3.17.2] Software settings are available for configuring all resources.** All buses and devices on both the system board and all expansion cards must be capable of being configured by the operating system and by software, such as the Device Manager in Windows, so that the user does not need to open the PC case to change the configuration. DIP switches on boot devices can be used for an initial power-on default state or for non-Plug and Play system compatibility, but such settings must be capable of being overridden by software configuration after power on occurs under Plug and Play operating systems.

Note: This requirement does not apply for jumper settings used by the OEM to set CPU speed, select a keyboard, or make other basic system-related settings in the factory. This requirement applies only for settings that the end user must make to configure the hardware.

?? **[3.17.3] Dynamic disable capabilities are supported for all devices.** All devices must be capable of being automatically disabled by the system. Also, disabling the device must result in the freeing of all its resources for use by other devices.

The following devices are exempt from this requirement: all legacy devices using the I/O range under 100h, keyboard controller, floppy disk controller (FDC), hard disk controller, VGA memory and I/O addresses, and any BIOS memory ranges required for legacy boot support.

[3.18.] Connections use icons, plus keyed or shrouded connectors, with color coding

This requirement helps ensure that the end user can correctly make the physical connections required for adding a device to a system. This requirement includes the following:

?? **[3.18.1] Connector's physical design ensures that the user cannot insert it into the wrong port.** Wherever possible, keyed or shrouded connectors or other configurations should be used to prevent misconnection. For specific requirements related to keyed connectors and cables for I/O controllers and peripherals, see Chapter X "Buses and Interfaces."

?? **[3.18.2] Icons are provided for all external connectors.** The icons can be molded, printed, or affixed as permanent stickers, which can include text. Icons can be based on existing vendor designs or on the examples listed on http://www.pcdesguide.org/documents/icons.htm.

Mobile PC Note

For mobile PC designs, connector icons might not fit on the back of the case. In such designs, it is acceptable to wrap the icons to the bottom of the unit or place them on the inside of an access door.

?? **[3.18.3] Systems and retail peripherals use a color-coding scheme for connectors and ports.** All PC 2001 systems must implement a color-coding scheme for their ports and device connectors.

Color coding is required for all desktop system and device connectors. The standard color coding using the colors published in *PC 99 System Design Guide* is required for all non-legacy devices. These required color codes must be implemented on PC desktop systems and on retail peripherals.

Standard colors are *not* required for the following legacy devices (because these cannot be included with PC 2001 systems): MIDI/game, parallel, serial, and PS/2 keyboard and mouse.

Required Color Codes for Connectors

Connector	Color	Pantone
Analog VGA	Blue	661C
Audio line in	Light blue	284C
Audio line out	Lime	577C
Digital monitor/flat panel	White	
IEEE 1394	Grey	424C
Microphone	Pink	701C
MIDI/game	Gold	131C
Parallel	Burgundy	235C
PS/2-compatible keyboard	Purple	2715C
PS/2-compatible mouse	Green	3395C
Serial	Teal or Turquoise	322C
Speaker out/subwoofer	Orange	157C
Right-to-left speaker	Brown	4645C
USB	Black	426C
Video out	Yellow	123C
SCSI, network, telephone, modem, and so on	None	—

Mobile PC Note Mobile PCs are not required to comply with the requirement for color coding.

[3.19.] Hot-plugging capabilities for buses and devices meet PC 2001 requirements

Note to Reviewers: In the 0.5 draft, these requirements might be in the appropriate chapters for technolgies, such as USB or IEEE 1394.

To ensure reliable support for hot-plugging capabilities, the following requirements must be met:

?? **[3.19.1] USB, IEEE 1394, and PC Card devices and buses support hot-plugging.** When designed under their respective specifications, USB, IEEE 1394, and PC Card all support hot-plugging. Any device designed to use any of these connections must support being added or removed while the system is fully powered on.

The exception to this requirement is any device required for booting such as the primary graphics adapter. For information about supporting multiple graphics adapters, see Chapter X, "Graphics Adapters."

?? **[3.19.2] Hot-plugging for PCI devices uses ACPI-based methods.** Hot-plugging is not required for PCI devices. Windows 98 and Windows 2000 support dynamic enumeration, installation, and removal of PCI devices only if there is a supported hardware insert/remove notification mechanism. The notification mechanism is defined as part of the bus standard for CardBus bus controllers. For other solutions, such as those required for docking stations or other devices, the hardware insert/remove notification mechanism must be implemented as defined in Section 5.6.3 of the ACPI 1.0b specification.

In order to properly function with the native support in the operating system, developing industry standards such as those referred to as PCI Hot Plug and Compact PCI must use ACPI-based methods for supporting hardware insertion and removal as defined in the ACPI 1.0b specification.

?? **[3.19.3] All removable media support media status notification.** For details and for design guidelines, see Chapter X, "Storage."

For implementation details and for additional design guidelines, see the article about hot-plugging support at http://www.microsoft.com/hwdev/busbios/rem_devs.htm.

[3.20.] If implemented, Device Bay components comply with~~System includes~~ Device Bay 1.0~~ compatible bay~~

If implemented in a PC 2001 system, Device Bay capabilities must meet the following requirements:

?? The system includes a Device Bay Controller (DBC) compliant with Device Bay Specification, Version 1.0 or later. If the DBC is implemented as a USB device, it must be compliant with *USB Class Definition for Device Bay Controllers*, Version 1.0.

?? The system includes on USB port and one IEEE 1394 port for each Device Bay-capable bay in the system.

Any Device Bay peripherals that is provided with a PC 2001 system must meet the following requirements:

?? Device complies with *Device Bay Specification*, Version 1.0.

?? Device uses either the USB bus, the IEEE 1394 bus, or both.

?? If the device uses the USB bus, it must also comply with the relevant USB device class specifications.

[3.21.] Multifunction ~~add-on~~ devices meet PC 2001 device requirements for each device

Note to Reviewers: Microsoft is preparing a white paper that provides additional information for multifunction devices used with Windows 2000 and Windows 98. This white paper will be available on www.microsoft.com/hwdev/mf/ in Q4 1999.

Exceptions to this guideline are under review and will be clarified for the v0.7 draft of this Design Guide.

Multifunction ~~add-on~~ devices can contain more than one device. They must comply with requirement 3.16, "Device driver and installation meet PC 2001 requirements," including the requirements for automated software-only settings for device configuration, device drivers, and Windows-based installation. In addition, the following requirements must be met:

?? **[3.21.1] Each enumerated device has a unique device ID.** Each function or device on the multifunction add-on device that is individually enumerated ~~by the BIOS~~ must provide a device ID for the bus it uses.

?? **[3.21.2] ~~System~~ Windows can separately access and configure each logical device.** ~~The system~~ Windows must be able to separately access each logical device that is individually enumerated ~~by the BIOS~~, configure the device resources independently, and disable individual devices in the event of a conflict.

?? **[3.21.3] Each enumerated device meets its own resource requirements.** For each individually enumerated device, resource configuration requirements are the same as for an equivalent device on a separate expansion card. This requirement means that registers cannot be shared among individually enumerated devices on a multifunction add-on device, but it does not supersede device requirements among different bus classes.

~~The exception to this requirement is a device such as a multifunction PCI device that supports several functions but uses only a single set of relocatable resources. When each device is not individually enumerated, there is no requirement to provide separate IDs and resources for each function on the device. However, see also requirement 9.8, "Functions in a multifunction PCI device do not share writeable PCI Configuration Space bits."~~

~~This exception refers solely to multifunction devices *of the same device class*. If different functions within a multiple-function device require separate class drivers—for example, a combination PCI network adapter and modem—then each function must provide a unique PCI SID and SVID that will allow the proper driver to be loaded for each separate function.~~

~~Multifunction devices that contain functions from separate classes will not be properly recognized during an operating system upgrade—and therefore drivers will not be properly upgraded—unless unique IDs are provided for each device.~~

Note that a "supervisory" driver that loads different drivers for the individual functions does not work well with Windows. In particular, driver support is likely to be lost in cases of operating system re-installation or upgrade, or with distribution of new drivers via Windows Update. Therefore, these supervisory drivers must be avoided.

?? **[3.21.4] For PC 2001, separate drivers are required for separate functions.**

[3.22.] All devices support correct 16-bit decoding for I/O port addresses

For implementation information, see *Legacy Plug and Play Guidelines.*

[3.23.] [REDUNDANT] All PC 2001 input devices support Microsoft DirectInput and work simultaneously

Note to Reviewers: See the Input chapter.

[3.24.] Each bus meets written specifications and PC 2001 requirements

~~In the past, some bus designs did not fully implement all of the bus requirements on every expansion card connector.~~Each bus and connector used in the system must meet all the requirements for that bus as defined in Chapter X, "Buses and Interfaces."

Each bus and device provided in a PC 2001 system must also meet the current Plug and Play specifications related to its class, including requirements defined in the *Advanced Configuration and Power Interface Specification*, Version 1.0b, and the clarifications published for some Plug and Play specifications. This guideline includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities.

PC 2001 I/O Devices and Peripherals

See the details in specific chapters later in this guide.

~~**3.29 [DELETE] System includes keyboard connection and keyboard**~~

~~**3.30. [DELETE] System includes pointing device connection and pointing device**~~

~~**3.31. [DELETE] System includes connection for external parallel devices**~~

~~**3.33. [DELETE] System includes IR devices compliant with IrDA specifications**~~

~~**3.35. [DELETE] System includes audio support that meets PC 2001 requirements**~~

[3.36.] System includes ~~a modem or other~~ public network communications support

Wide Area Network (WAN) devices can provide direct connection to Internet Service Providers.

Qualifying WAN devices include but are not limited to:

?? PSTN (voiceband) modems, see Chapter X, “Modems”

?? ISDN modems, see Chapter X, “Network Communications”

?? Cable Modems, see Chapter X, “Network Communications”

?? DSL Modems, see Chapter X, “Network Communications”

?? Wireless modems, see Chapter X, “Modems”

If a WAN device is not built into the system, this requirement could be met by:

?? Additional USB port, beyond appropriate system requirements (see 3.25 for Desktop, 6.5 for Mobile)

?? IEEE 1394 slot

?? CardBus slot

?? The ethernet adapter provided to meet 3.37 when internet access is provided to the local network through a gateway or other shared Internet connection.

?? An Ethernet adapter that is additional to that provided to meet 3.37, reserved for connection to external broadband modem, for example, cable modem or DSL modem

[3.37.] System includes a LAN connection~~10 BaseT or HomePNA solution~~

Local area network devices provide access to other networked devices, including PCs, shared peripherals and shared Internet Access.

Qualifying LAN devices include but are not limited to:

?? IEEE 802.x adapters (Ethernet, Token Ring, 802.11 wireless)

?? Home networking media (HomeRF, HomePNA)

?? IEEE 1394 ~~port~~slot

?? Cardbus slot (for example, mobile PC)

If a LAN device is not built into the system, this requirement can be met by the capabilities listed in 3.36 which includes an additional USB port beyond core system minimum requirements.

Note: It is recognized that OEMs supply PC systems to corporations with specific feature requirements. For example, a customer might want to insert network adapters at the end-user site. A PC system submitted for compliance testing must include a network adapter.

~~**3.38. [DELETE] System includes smart card support**~~

PC 2001 Graphics and Video

~~**3.39. 3.44 [DELETE] Graphics adapter meets PC 2001 minimum requirements**~~

Note to Reviewers: See the Graphics/Video chapter for related requirements.

[3.41] PC 2001 system provides video playback capabilities~~**System meets PC 2001 DVD-Video and MPEG-2 playback requirements, if system supports DVD-Video**~~

Video playback capability is required in PC 2001 systems. Systems must meet the requirements defined in Chapter X, "Video."

[3.43] If video capture is implemented, ~~**System supports PC 2001**~~ **analog video input and capture capabilities comply with PC 2001 guidelines**

If video-capture capability is implemented in a PC 2001 system, it must meet the requirements defined in Chapter X, "Video."

[NEW.3.105] If digital video interface is implemented, components comply with PC 2001 guidelines

Digital interfaces for monitors comply with the DVI specification and requirements in Chapter 10, "Graphics Adapters."

PC 2001 Storage

~~3.46. – 3.47 [DELETE]~~

Note to Reviewers: See the Storage chapter for related requirements.

[3.48] PC2001 system includes hard disk and controller

Host controller for hard disk devices must support bus mastering, as defined in Chapter X, "Buses and Interfaces." Bus master capabilities must meet the related specification for the particular controller.

Use of the ISA bus by storage devices is not acceptable for PC 2001 systems.

Hard disk and optical devices must meet the requirements defined in Chapter X, "Storage."

Note: This requirement does not apply for closed-case platforms that do not include a hard drive and are designed to boot from the network.

[3.34.] ~~System includes~~ PC 2001 system includes ~~compatible~~ CDRW or DVD ~~drive~~ and controller

The CDRW or DVD drive and controller must meet the requirements defined in Chapter X, "Storage," and Chapter X, "Buses and Interfaces."

Note: This requirement does not apply for closed-case platforms that do not include a hard drive and are designed to boot from the network.

Mobile PC Note

For guidelines to any implementation of optical storage on mobile PCs, see Chapter 6, “Mobile.”

[3.50.] Floppy disk capabilities, if implemented, do not use legacy FDC

To support migration away from legacy devices, floppy disk drives on PC 2001 systems must be based on a solution other than an FDC. Solutions could include an MMC-2-compliant ATAPI floppy drive, USB, PC Card, SCSI, or an ATA expansion card. ~~For implementation details, see Chapter X, “Storage.”~~

The device must also meet the general requirements defined in Chapter X, “Storage.”

Legacy Removal Requirements

This section defines the hardware, BIOS, and software requirements for legacy-reduced and legacy free systems. For background information about the goals of legacy removal for PC 2001, see “Relevance of Legacy Removal” in Chapter 2, “Easy PC Initiative.”

All PC 2001 computers accomplish some level of legacy removal, as indicated in the "Legacy Reduction Requirements." For system designers who want the

operating system to identify the computer as a legacy free system, the "Legacy Free Requirements" section contains additional requirements.

Mobile PC Note Mobile systems may support port 60/64 interfaces for integrated keyboard and pointing devices.

PC 2001 Legacy Reduction Requirements

This section defines requirements for migration away from legacy architectures for all PC 2001 systems.

[3.28.] System does not include ISA expansion devices or slots

PC 2001 systems do not include any ISA expansion devices or user-accessible ISA slots.

Systems that are not designed to meet PC 2001 legacy free guidelines can use ISA protocols and signaling, or ISA-like protocols and signaling for implementations of legacy devices. For example, these legacy devices are the controllers for serial, parallel, 8042, floppy, and so on. These devices are additional to integrated system devices. These devices are allowed and must meet the requirements defined in *Legacy Plug and Play Guidelines.*

[NEW.3.106] BIOS supports legacy removal.

All PC 2001 systems must achieve the following minimum level of BIOS support for legacy removal and support of replacement technologies:

?? **[NEW.3.106.1] No BIOS boot dependencies on ISA, and no ISA-related components appear on BIOS setup screen.** USB external connectors and USB input device support must be enabled by default in the BIOS, and the BIOS must ensure that USB input devices, such as keyboards and mice, are available at boot time. This includes implementing all related support defined in *USB Device Class Definition for Human Interface Devices, Version 1.1* (HID 1.1), with particular attention to the Keyboard Boot Protocol. The BIOS must correctly handle long descriptors read from any USB device attached to the PC at boot time. For USB keyboards and mice connected through hubs, the BIOS must also be able to enumerate the devices across the USB topology.

If an internal floppy is not present, the BIOS must support the USB-based floppy as a secondary boot device.

[NEW.3.107] Preinstalled components and upgrades do not require MS-DOS or legacy interfaces

The following requirements are defined.

Note to Reviewers: Is floppy media still needed for mobile systems that are not equipped with optical drives or that don't have the ability to connect to a network to do system recovery?

?? **[NEW.3.107.1] Peripherals use non-legacy interfaces.** Peripherals included with the system must not rely solely on the following legacy interfaces:

?? serial

?? parallel

?? PS/2

?? ISA-based IR

A peripheral can include both a legacy interface and a non-legacy interface such as PCI, USB, IEEE 1394, or CardBus.

Mobile PC Note

This guideline does not apply to the integrated keyboard and pointing device of mobile PCs.

Note to Reviewers: Is floppy media still needed for mobile systems that are not equipped with optical drives or that don't have the ability to connect to a network to do system recovery?

[NEW.3.107.4] Secondary boot and upgrade capability is independent of FDC floppy drive. The system must be capable of recovery and upgrade of the hard drive image and BIOS independent of an FDC-based floppy drive. Options include the CD or DVD drive, other ATAPI drives, or USB drives.

PC 2001 Legacy Free Requirements

This section defines the hardware requirements for legacy free systems that will be implemented under PC 2001 guidelines.

The basic goal for the legacy free system requirements is that the operating system, devices, and end users cannot use any of the following:

?? ISA slots or devices

?? Legacy floppy disk controller (FDC)

?? PS/2, serial, parallel, and game ports

Revisions to the ACPI specification provide a mechanism that allows the BIOS to report whether a system provides the services of these components and interfaces. If the BIOS reports that the system is legacy free, the system must meet the guidelines provided in that section.

Note: The requirements for legacy free systems are additional to those defined for legacy reduced systems.

[NEW.3.108] BIOS supports ACPI legacy free reporting mechanism.

ACPI FADT settings, as described in *ACPI Changes for Legacy Free PCs* (available on the web at http://www.microsoft.com/hwdev/newpc/), must be supported and correctly implemented in PC 2001, including support for reporting legacy free and hard reset/boot capabilities:

?? ACPI reset mechanism as defined in ACPI section 4.7.5.

?? LEGACY_DEVICES and 8042 flags set as defined in ACPI section 5.2.1.

Note that the 8042 flag must be set to 0 in desktop systems, but may be set to 1 in mobile PCs that require the presence of the 8042 controller.

?? Debug Port Table in the BIOS, as described in ACPI section 5.2.11.

[NEW.3.109] Legacy ports cannot be detected.

The following ports are considered legacy ports and they must be replaced by USB or other non-legacy equivalents: FDC, external serial, parallel, PS/2-compatible ports, ISA-based game ports, and MPU-401 (MIDI) ports. These ports must not be available for external connection and must not be detected by the operating system as enabled.

Systems can provide Super I/O-based IrDA support through 2001.

No restricted ports can be used. Whether on the motherboard or included with the devices, hardware must not use any ports historically used for legacy devices, as shown in Table 1. If hardware is present and disabled, ACPI declaration must claim resources that cannot be freed up.

Table 1. Restricted Port Addresses

Device	I/O Address	Interrupts
COM[1]	2E8–2EF 2F8–2FF 3E8–3EF 3F8–3FF	IRQ3, 4
LPT	278–27A 378–37A 3BC–3BE	IRQ 7
Joystick/game port	0201	
MPU-401 (MIDI)	0330–0331	
Floppy disk controller (FDC)	3F0–3F7	IRQ 6
Keyboard/mouse controller[2]	0060, 0064	IRQ 1, 12

[1] These addresses can be used for as a debug port option.

Mobile PC Note

[2] These addresses and interrupts can be used in mobile PCs

[NEW.3.110] System supports PC2001 legacy free debug capabilities

In legacy free systems, an internal or external debug interface must be present and supported.

Note to Reviewers: The following options are available:

If a Super I/O device is present, implement an internal 10-pin COMM Port header for desktops. This is described in Intel's Hardware Implementation Guide for Easier to Use Consumer PCs in 1999, available at [TBD]. If the Super I/O device supports the capability, the I/O base address of the COMM Port must be located at other than a legacy port location. This option must also be implemented in legacy reduced systems that have a Super I/O but do not support an external COMM Port connector.

Mobile PC Note: For mobile systems, alternative solutions are under development: for example a low profile mini-connector that is located behind a service panel.

If the Super I/O device is not present, implement an internal LPC bus header that supports a standard module with a Super I/O device. Design collateral for desktop and mobile systems are under development.

A proposal for USB-based debug solution is under development and will be referenced, if available, in a later revision of this design guide. Contingent on operating system support for a USB-based debugger, implement appropriate support in the chipset to work with an external USB debug adapter. In this case, no header support is required.

[NEW.3.111] A20M# is always de-asserted (pulled high) by the hardware at the processor

Note to Reviewers: More details will be provided for this guideline in a future draft.

Manageability Component Instrumentation Requirements

This section presents new requirements for PC 2001 systems related to the Wired for Management (WfM) initiative and the Zero Administration initiative for Windows. The WfM initiative seeks to raise the level of management capabilities for mobile, desktop, and server platforms. The Zero Administration initiative seeks to ensure a controlled, highly manageable enterprise.

The baseline for these requirements is *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0* (WHIIG), which also defines the

Windows-specific requirements of the *Wired for Management Baseline Specification, Version 2.0*, for hardware instrumentation.

Collectively, the items in this section represent the Manageability Baseline requirements for Windows 2000. Platform management information requirements are defined for two key areas:

?? Component instrumentation: Interfaces through which information is supplied by platform management components.

?? Management information providers: Interfaces used by applications to access platform management information.

Tips for implementing management capabilities. For PC 2001 systems and components, these are the design steps to pursue:

?? For each component, implement the component instrumentation features defined for PC 2001 systems in WHIIG.

?? For each component, extend the Web-Based Enterprise Management (WBEM) and Common Information Model (CIM) schema to expose the device's custom features in any CIM-ready management browser.

?? For all instrumented components, test against the baseline features required in WHIIG.

?? For those components that require Windows Management Instrumentation (WMI), ensure that WMI is enabled in device minidrivers as defined in the Windows 2000 DDK.

?? Refer to WHIIG for other driver requirements and design tips.

[3.51.] System supports WHIIG

The related requirement is defined in *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0.*

Mobile PC Note

Support for WHIIG, WMI, and enabling a management information service provider are required for mobile systems targeted for use with Windows 2000.~~that come with Windows 2000 preinstalled.~~

[3.52.] System includes driver support for WMI

Note to Reviewers: This is redundant with guideline [3.51]

[3.53.] Management information service provider enabled by default

Note to Reviewers: This is redundant with guideline [3.51]

[3.54.] Expansion devices on desktop systems can be remotely managed

Devices provided as expansion devices must be capable of being remotely managed to ensure that control and TCO policies can be realized. For example, for any implementation of a floppy disk drive on a Windows 2000 system, the

drive must be capable of being remotely disabled as a boot selection and provisions must be made for locking.

Certain devices are not required to be capable of being remotely disabled, including the primary hard disk drive, the network adapter, and any standard devices that use legacy connections, such as a keyboard or pointing device that uses a PS/2-compatible connection. However, it must be possible that permissions, policies, or other methods can be used to remotely manage capabilities such as hard disk access or to control end-user ability to change the MAC address or configuration settings for the network adapter.

See also requirement [NEW 3.~~5~~101], "BIOS supports remote boot.~~meets PC 2001 requirements for boot support~~."

Checklist for PC 2001 Core System Guidelines

[3.1.] System performance meets PC 2001 minimum requirements
[3.2] System design meets ACPI 1.0b specification and PC 2001 requirements
[3.3.] Hardware design supports OnNow and Instantly Available PC initiatives
[3.4.] BIOS meets PC 2001 requirements for OnNow/Instantly Available PC support
[NEW.3.101] BIOS supports remote boot
[3.5.] BIOS includes local boot support
[3.55.] BIOS supports SMBIOS 2.3
[3.5.4] BIOS properly accommodates all dates
[3.5.5] BIOS supports security
[3.5.6] BIOS supports BIOS updates and revisions
[3.5.8] System BIOS supports debug port
[3.45.] System BIOS and option ROMs support Int 13h Extensions
[NEW.3.112] ROM BIOS interrupt handlers preserve values in all registers
[3.7.] Audible noise meets PC 2001 requirements
[3.8.] System and component design practices follow accessibility guidelines
[3.25.] PC 2001 system includes USB with 2 user accessible USB ports, minimum
[3.26.] If IEEE 1394 is implemented, all components meet PC 2001 guidelines
[NEW.3.103] If SCSI is implemented, all components meet PC 2001 guidelines
[NEW.3.104] If ATA/ATAPI is implemented, all components meet PC 2001 guidelines
[3.27.] If PCI is implemented, all components meet PC 2001 guidelines
[3.11.] Each device and driver meets PC 2001 device requirements
[3.12.] Each bus and device meets Plug and Play specifications
[3.13.] Unique Plug and Play device ID provided for each system device and add-on device
[3.14.] Option ROMs meet Plug and Play requirements
[3.15.] "PNP" vendor code used only to define a legacy device's Compatible ID
[3.16.] Device driver and installation meet PC 2001 requirements
[3.17.] Minimal user interaction needed to install and configure devices
[3.18.] Connections use icons, plus keyed or shrouded connectors, with color coding
[3.19.] Hot-plugging capabilities for buses and devices meet PC 2001 requirements
[3.20.] If implemented, Device Bay components comply with Device Bay 1.0
[3.21.] Multifunction devices meet PC 2001 device requirements for each device
[3.22.] All devices support correct 16-bit decoding for I/O port addresses
[3.23.] [REDUNDANT] All PC 2001 input devices support Microsoft DirectInput and work simultaneously
[3.24.] Each bus meets written specifications and PC 2001 requirements
[3.36.] System includes public network communications support
[3.37.] System includes a LAN connection
[3.41] PC 2001 system provides video playback capabilities
[3.43] If video capture is implemented, analog video input and capture capabilities comply with PC 2001 guidelines
[NEW.3.105] If digital video interface is implemented, components comply with PC 2001 guidelines
[3.48] PC2001 system includes hard disk and controller
[3.34.] PC 2001 system includes CDRW or DVD and controller

[3.50.] Floppy disk capabilities, if implemented, do not use legacy FDC

[3.28.] System does not include ISA expansion devices or slots

[NEW.3.106] BIOS supports legacy removal.

[NEW.3.107] Preinstalled components and upgrades do not require MS-DOS or legacy interfaces

[NEW.3.108] BIOS supports ACPI legacy free reporting mechanism.

[NEW.3.109] Legacy ports cannot be detected.

[NEW.3.110] System supports PC2001 legacy free debug capabilities

[NEW.3.111] A20M# is always de-asserted (pulled high) by the hardware at the processor

[3.51.] System supports WHIIG

[3.52.] System includes driver support for WMI

[3.53.] Management information service provider enabled by default

[3.54.] Expansion devices on desktop systems can be remotely managed

C H A P T E R 5

Workstation

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 10:35 AM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter provides a summary of the key requirements for workstations designed as PC 2001 systems. If there is a conflict with requirements made elsewhere in this guide, the items in this chapter have precedence for workstations. Unless a specific requirement or exception is defined in this chapter, all PC 2001 requirements apply as defined in Chapter [X], "Core System Architecture."

This chapter describes the requirements that define a workstation optimized to run Windows 2000 Professional and future versions of the Windows 2000 client operating system, and also to support Win32®-based and Win64®-based applications. Workstation PC is a platform for users whose principal computing tasks involve running mission-critical networked applications, engineering or scientific applications, media-authoring tools, or software-development tools.

Although Windows 2000 is used on stand-alone systems, the PC 2001 system requirements support the more common use of Windows 2000 as a platform for network productivity.

The key design issues for workstations include processor, memory, and bus architecture requirements that support intensive computational activities.

OEMs supply Workstation PC systems to customers with specific feature requirements. For example, a customer might want to insert network adapters at the end-user site. However, a Workstation PC system submitted for compliance testing must include all required features.

[4.1] Workstation meets all requirements for Core PC 2001

Each component indicated as a requirement for a Core PC system is also a requirement for workstations, as defined in Chapter [X], "PC 2001 Core System Architecture."

[4.2] Workstation system components meet minimum performance requirements

Minimum Workstation PC 2001 system component requirements include the following:

?? Minimum 700 MHz processor

?? System board is capable of supporting multiple processors. Although an OEM may ship a workstation configured with a single processor, the system must allow a second processor to be installed.

?? 128 MB RAM, minimum ~~(minimum of 64 MB RAM per processor for multiple processor configurations)~~

?? Minimum 512KB of cache, present and enabled

~~? Minimum 256K L2 cache (minimum of 256K L2 cache per processor for multiple processor configurations)~~

[4.3] Workstation supports multiple processors

Workstations implementing multiple ~~Intel Architecture~~ processors must meet the following requirements:

?? The system must employ those processors symmetrically.

?? Each processor must have a separate L2 cache.

?? The system must comply with the ACPI 1.0b specification (or later) and MultiProcessor Specification (MPS), Version 1.4 or later. ACPI will eventually supersede MPS.

?? Systems implementing either an ARC-compliant or an ACE-compliant ~~Alpha architecture~~ system meet the requirements for multiprocessor support.

[4.4] Workstation RAM can be expanded

~~If the capability for expanding RAM is implemented, w~~Workstation RAM must be capable of being expanded to ~~1~~ 2 GB, at minimum.

Note to Reviewers: Please let us know how this guideline affects your product roadmaps.

[4.5] Workstation system memory includes ECC memory protection

The system memory and external processor cache of both 32-bit ~~The system memory and L2 cache of both 32-bit~~ and 64-bit platforms must be protected with Error Correction Code (ECC) memory protection. All ECC RAM visible to the

operating system must be cacheable. The ECC memory subsystem hardware must be able to detect at least a double-bit error in one word and to correct a single-bit error in one word, where “word” means the width in bits of the memory subsystem. A detected error that cannot be corrected must result in a system fault.

Note to Reviewers: The RAM caching listed here only.

[4.6] [REDUNDANT] Workstation includes APIC support

~~This requirement does not apply for Alpha architecture workstations.~~

~~The workstation must include Advanced Programmable Interrupt Controller (APIC) support that complies with ACPI x.x by including the Multiple APIC Description Table (ACPI Section 5.2.8).~~

~~Features such as targeted interrupts, broadcast interrupts, and prior-owner interrupts must be supported. Intel Architecture processor implementations can use the Intel APIC component.~~

~~If any chip set in the system includes an APIC that uses the APIC bus, then the APIC bus must be clocked and connected to all APICs in the system, including those embedded within the processors.~~

~~Chip manufacturers implement I/O APICs in their chip sets, but it is up to the system manufacturer to correctly wire the APIC to the processor. Without an I/O APIC wired in the system, any local APICs are useless -- the possible additional IRQs for device interrupts are not made available to the Windows operating system.~~

~~For background information, see *Key Benefits of the I/O APIC* at http://www.microsoft.com/hwdev/newpc/io-apic.htm.~~

~~For technical information about how to implement this requirement, see the related chip set guide from your chip set vendor.~~

Note to Reviewers: This guideline is redundant with [3.1.3].

[NEW.4.101] PCI bus, bridges, and adapters support DAC command

Note to Reviewers: The following section taken from Server Design Guide V2.0, and the associated FAQ (requirement #18) and tuned for workstation

On 64-bit platforms that provide support for more than 4 GB of system memory, all PCI adapters, including 32-bit PCI adapters, must be able to function properly in the system. In addition, certain classes of adapters, such as those on the primary data path where the majority of network and storage I/O occurs, must also be able to address the full physical address space of the platform. For 32-bit

PCI adapters that will be used on the primary data path, this means that the adapter must be able to support the PCI Dual Address Cycle (DAC) command.

Additionally, all 32-bit PCI buses, host bridges, and PCI-to-PCI bridges must also support DAC.

On 64-bit platforms, all PCI bridges on the motherboard must support DAC for inbound access, and DAC-capable devices must not be connected below non-DAC capable bridges, e.g. on adapter cards. New 64-bit adapters should be DAC capable. This DAC requirement does not apply to outbound accesses to PCI devices; however, for systems where DAC is not supported on outbound accesses to PCI devices, the system BIOS must not claim that the bus aperture can be placed above the 4 GB boundary.

There are special considerations that system designers must address when using legacy devices, adapters, and bridges in systems that provide support for more than 4 GB of memory. For information on how Windows 2000 will behave in the case where a non-DAC capable bus is detected on a system that supports more than 4 GB of memory, please see http://www.microsoft.com/[placeholder]. For information on hardware design issues for these systems, please see http://www.microsoft.com/[placeholder].

[4.8] Workstation supports 64-bit I/O bus architecture if system includes 64-bit processors

Note to Reviewers: The following section taken from Server Design Guide V2.0, and associated FAQ, (requirement #19) reworded for a workstation context.

64-bit PCI adapters must be able to address any location in the address space supported by the platform.

The workstation must support a 64-bit PCI bus if the workstation has 64-bit processors or has the capability to support greater than 4GB of physical memory.

[NEW.4.102] 66-MHz and 64-bit PCI buses within a workstation comply with PCI 2.2 or later requirements

Note to Reviewers: The following section taken from Server Design Guide V2.0, (requirement #36) reworded for clarification

If either 66 MHz, or 64-bit PCI buses are implemented in a workstation, all devices connected to these buses must meet the requirements defined in PCI 2.2 or later.

[NEW.4.103] For 64-bit platforms, each device and driver meets PC 2001 device requirements

Note to Reviewers: The following section was extracted from Server Design Guide V2.0, (requirement #54)

For workstations implementing a 64-bit platform, each device included within the workstation must have 64-bit Windows 2000 compatible drivers

[4.10] Graphics subsystem supports workstation performance demands

The graphics-intensive application requirements for hardware often exceed the hardware capabilities of the graphics subsystem.

If implementing a workstation supporting user applications that rely on DirectX (in particular, DirectDraw, Direct3D, DirectShow), the graphics subsystem must include hardware acceleration supporting the features, performance, and compatibility requirements of the associated DirectX architecture. For information about requirements for hardware acceleration supported by DirectX, see Chapter [X], "Graphics Adapters."

If implementing a workstation supporting user applications that rely on Windows Image Acquisition, the graphics subsystem must include hardware supporting the features, performance, and compatibility requirements of Windows Image Acquisition. For information about requirements for Windows Image Acquisition, see Chapter [X], "Digital Still Image Peripherals."

Note to Reviewers: The following requirement will be defined in the Graphics chapter in a future version.

If implementing an AGP Pro Bus, follow the AGP Pro 1.1 specification (or later), found at http://www.agpforum.org/specs_specs.htm.

[4.11] [REDUNDANT] SCSI storage components meet PC 2001 requirements

Note to Reviewers: For these requirements, see the Storage or Buses and Interfaces chapters

[4.12] Multiple hard drive system meet Workstation PC 2001 performance requirements

Note to Reviewers: The intended message here is that for single drive systems, ATA Ultra/66 is OK. For systems attaching multiple drives on an I/O channel SCSI is required.

When implementing a workstation storage subsystem capable of supporting multiple hard drives, the hard drives must either be allocated independent ATA Ultra/66 (minimum) I/O channels (one channel per physical storage device) or may be grouped and interconnected using SCSI interfaces. This requirement

ensures workstation data throughput while allowing less costly ATA interfaces on systems that require only a few drives.

If implementing a redundant array of inexpensive disks (RAID) drive storage subsystem, these arrays can be configured as:

?? RAID 0: Improve performance (multiple spindle access and striping)

?? RAID 1: Data mirroring on parallel drives

?? RAID 5:for data integrity using distributed data and CRCs

~~If multiple hard drives are implemented, the design must provide a means for the operating system to determine the boot drive. One implementation of boot-drive determination in multiple-drive systems is defined in Section 5.0 of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. The format defined in this specification is what Windows 2000 uses to determine the boot drive when new bootable devices are introduced on the system. The system designer can use an equivalent method for boot-drive determination, but the method must ensure that the boot drive is recognized by the Windows 2000 operating system.~~

For all related requirements for storage, see Chapter [X], “Storage and Related Peripherals.”

~~**[NEW] Workstation includes ‘new technologies’**~~

~~**[NEW] Workstation platform meets minimum legacy removal requirements**~~

~~Workstations platforms are not to be configured with the following legacy devices:~~

~~? Super I/O~~

~~? PS/2-compatible keyboard~~

~~? Serial and parallel ports~~

~~? Legacy FDC-based floppy disk drive~~

Checklist for Workstation

[4.1] Workstation meets all requirements for Core PC 2001

[4.2] Workstation system components meet minimum performance requirements

[4.3] Workstation supports multiple processors

[4.4] Workstation RAM can be expanded

[4.5] Workstation system memory includes ECC memory protection

[4.6] [REDUNDANT] Workstation includes APIC support

[NEW.4.101] PCI bus, bridges, and adapters support DAC command

[4.8] Workstation supports 64-bit I/O bus architecture if system includes 64-bit processors

[NEW.4.102] 66-MHz and 64-bit PCI buses within a workstation comply with PCI 2.2 or later requirements

[NEW.4.103] For 64-bit platforms, each device and driver meets PC 2001 device requirements

[4.10] Graphics subsystem supports workstation performance demands

[4.11] [REDUNDANT] SCSI storage components meet PC 2001 requirements

[4.12] Multiple hard drive system meet Workstation PC 2001 performance requirements

CHAPTER 6

Mobile

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 10:38 AM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter provides a summary of the key PC 2001 requirements for mobile PCs, docking stations, and mini-docks. Mobile PC systems have thermal, portability, battery run-time and battery life, size, weight, and connectivity tradeoffs required for their design that differ from the tradeoffs made for stationary systems.

Unless a specific requirement or exception is defined in this chapter, all requirements apply for mobile PCs as defined elsewhere in this guide. If there is a conflict with requirements or recommendations made elsewhere in this guide, the items in this chapter have precedence for mobile PCs.

Mobile PC System Design Requirements

This section summarizes the additional design exceptions and design requirements for mobile PCs.

Unless an explicit exception is stated in this section, the PC 2001 requirements apply for mobile PCs as defined elsewhere in this guide. However, if there is any

conflict with requirements or recommendations stated elsewhere in this guide, the items in this section have precedence for mobile PCs.

6.1 Mobile PC performance meets Mobile PC 2001 minimum requirements

For mobile PC systems based on Intel Architecture compatible processors, minimum PC 2001 performance requirements are the following:

?? ~~233~~600 MHz processor with 128K L2 cache.

Note: The processor requirement does not specify a particular processor form factor or package type.

Note to Reviewers: Please comment on how this (and other requirements in this chapter) will apply for Mini-notebook

~~? 3264 MB minimum system memory. A minimum of 28 MB of memory must be available for the system to use at boot time. These minimum memory requirements do not preclude applications that use dynamically allocated memory for audio or video playback or other temporary usage. The basic PC 2001 limitations for memory available to the operating system apply for mobile PCs, as defined in the requirement X.Y, "System memory meets PC 2001 minimum requirements."~~

~~Mini-notebook Note~~

~~For mini-notebook systems, the minimum system performance requirement is 233-MHz processor with no L2 cache and 16 MB RAM.~~

6.2 Mobile PC supports Smart Battery or ACPI Control Method battery

?? **6.2.1 Smart Battery meets PC 2001 requirements.** If Smart Battery is implemented, the following requirements apply:

?? An ACPI embedded controller-based (EC) System Management Bus (SMBus) interface is required, as described in Section 13 of the ACPI 1.0b specification.

?? The Smart Battery must support the complete command set and meet the accuracy requirements defined in *Smart Battery System Specification, Version 1.1*.

?? A Smart Battery Charger, if used, must comply with the command requirements defined in *Smart Battery Charger Specification, Version 1.1*.

~~? A single-battery system that does not use a Smart Battery Charger must report the presence or absence of AC power and issue AC state change notifications by way of the EC interface, using Smart Battery Charger commands.~~

~~? A multiple-battery system that does not use a Smart Battery Charger must report the presence or absence of AC and issue AC state change notifications using the EC by emulating a Smart Battery Selector status register.~~

- ~~? A multiple-battery system that does not use a Smart Battery Charger must report the presence or absence of AC and issue AC state change notifications using the EC by emulating a Smart Battery Selector status register.~~
- ?? Single battery system must comply with the intent of the Smart Battery Selector System Manager Specification, Version 1.0 and expose emulated Smart Battery Selector System Manager registers to the operating system.
- ?? A multiple-battery system may use either a Smart Battery System Manager that complies with the *Smart Battery System Manager Specification, Version 1.0,or* it may emulate the functionality of the *Smart Battery System Manager*. The battery selection or alternate control scheme must comply with the intent of the *Smart Battery System Manager Specification.* In either case, the multiple battery system must expose actual or emulated *Smart Battery Selector System Manager* registers to the operating system.

The intent is that battery systems returning "Smart Battery System" data by way of the EC SMBus interface do so in a manner consistent with the Smart Battery System specifications. They must return all battery data, the charger status, and all selector or system manager registers in a manner transparent to the operating system, allowing the standard Smart Battery System drivers provided with the operating system to work properly.

All Smart Battery specifications are available at http://www.sbs-forum.org.

Note to Reviewers: Please tell us the potential impact of making the emulation items (above) a requirement.

?? **6.2.2 ACPI Control Method Battery meets PC 2001 requirements.** If an ACPI Control Method Battery, as defined in Section 11 of the ACPI 1.0b specification, is implemented, the following requirements apply:

?? All data returned must be meaningful and accurate. If the accuracy cannot be guaranteed, return the unknown value, which typically is 0xFFFFFFFF.

?? Although most of the data fields returned by a Control Method battery are optional or recommended in the ACPI 1.0b specification, the following data fields are required for PC 2001:

Field	Requirements
_BIF field	Power Unit must report 0x0000000. That is, batteries are required to report their Battery Remaining Capacity in mWH and their Battery Present Rate in mW.
	Design Capacity, reported in mWH.
	Design Capacity of Low.
_BST	Battery Remaining Capacity, reported in mWH.
	Battery Present Rate, reported in mW.

_BTP ~~support~~	The BTP must be available to set a trip-point to generate an SCI when the *Battery Remaining Capacity* reaches the value specified.

?? Batteries must be able to supply at least the capacity they report (Battery Remaining Capacity) at all times, even when the system is running on AC power. It is acceptable to supply more energy than they report, but they must never over-report capacity.

?? Batteries must accurately report the Battery Present Rate, providing data that is not stale.

~~6.3 [DELETE] Expansion capabilities of mobile PC are accessible to users~~

Note to Reviewers: This is not a PC 2001 requirement

6.4 Mobile PC connections use icons plus keyed or shrouded connectors

This requirement is the same as for PC 2001 desktop systems, except that:

?? Connector icons may be placed on the bottom of the unit or on the inside of access doors. ~~for Mobile PC designs, with small height considerations, connector icons might not fit on the back of the case. In such cases, it is acceptable to wrap the icons to the bottom of the unit or place them on the inside of an access door.~~

?? Mobile PCs are not required to implement color coding for connectors.

6.5 Mobile PC includes one USB port

A mobile PC must have at least one user accessible USB port that conforms with the USB requirements in Chapter 8, “Buses and Interfaces.

6.6 [REDUNDANT] USB-connected device does not maintain fully on power state

Note to Reviewers: Mobile implementation details for buses will be placed in the buses chapter. Mobile PC 2001 implementation requirements for USB are defined in Chapter X, “Buses and Connectors.”

[6.7] If implemented, Mobile PC includes compliant IEEE 1394

The IEEE 1394 implementation must meet the IEEE 1394 device requirements found in Chapter 8, "Buses and Interfaces." If externally accessible sockets are provided, at least one IEEE 1394 supported socket must be provided.

6.8 Mobile PC includes CardBus

At least one 32-bit Type-2 CardBus slot (not 16-bit) is required. All CardBus implementations must comply with the requirements defined in Chapter 9, “Buses and Interfaces,” including information about the default initialization of the

CardBus controller under both Windows 98 and Windows 2000 Professional operating systems.

~~**Note:** Each device in a multifunction add-on device—such as a CardBus card—must separately meet the power management device class specifications for its device class and be independently power managed. This means that both device A and device B on the same add-on card do not have to be idle before the devices can be power managed.~~

6.9 Mobile PC keyboard and pointing device meet PC 2001 requirements

A PC 2001 Mobile PC system must have an integrated pointing device, integrated input devices (keyboard or speech I/O).

The internal keyboard and any built-in pointing devices, such a mouse, stylus, pen, touch pad, touch screen, trackball, stick, and so on, required for a mobile PC should use standard system-board devices. The USB port can be used to support the requirement for external pointing device and keyboard connections.

For more information, see Chapter X, "Input Devices," which also provides information about implementing the Windows and Application logo keys on mobile PCs.

The BIOS and the driver for the internal pointing device must accommodate standard external pointing devices such that all features of the external device are available when it is attached to the system.

~~At a minimum, if the internal pointing device is a PS/2-type device, the BIOS must provide an option to detect when an external PS/2-type pointing device is connected at startup and disable the internal pointing device. In this case, the driver for the internal pointing device must not load. This should be the default BIOS option.~~

~~The *required* default BIOS option is to provide an option to disable the internal pointing device when any externalPS/2-type pointing device is detected at startup. In this case, the driver for the internal pointing device must not load.~~

6.10 [MOVED] Mobile PC includes IR devices compliant with IrDA specifications

Note to Reviewers: This guideline has moved to Chapter 9, "Input Devices."

6.11 Mobile PC includes support for installing the operating system

The Mobile PC system, as purchased, might not include all peripherals required for operating system installation. This basic PC 2001 requirement is met as long as it is possible for the user to obtain the required device support for operating system installation, even if it requires a separate purchase.

[NEW.6.101] Mobile PC has integrated display

Mobile PC has integrated display that meets the requirements in Chapter 10, "Graphics."

[NEW.6.107] Mobile PC provides PC 2001 graphics capabilities

Mobile PC meets the requirements in Chapter 10, "Graphics" with exceptions noted therein.

[NEW.6.104] If implemented, external video connector meets Mobile PC requirements

Mobile PCs are not required to include an external video connector. If an analog video connector is implemented, it can be either a VGA connector or DVI connector. If a digital monitor interface is implemented, then a DVI connector is required. The video connector must meet the requirements defined in Chapter 10, "Graphics."

[NEW.6.105] If implemented, TV output meets Mobile PC requirements

Mobile PCs are not required to include an external TV output, but if implemented, it must meet the requirements in Chapter 10, "Graphics."

6.12 [REDUNDANT] Mobile PC includes audio that meets Mobile PC 2001 audio requirements

A mobile PC audio system must meet the requirements in Chapter 12, "Audio."

[NEW.6.106] Mobile PC includes PC2001 hard disk as primary boot device

Mobile PC must include a PC2001 hard disk as its primary boot device. The drive must meet the requirements in Chapter 13, "Storage."

6.13 ~~Mobile PC includes communications device~~Communications capabilities meet Mobile PC 2001 guidelines

The presence of a CardBus slot on the mobile PC meets the PC 2001 requirement for providing access to the Internet, with the following exceptions:

?? If modem capabilities are integrated in the base platform, then the requirements for modems~~hen V.34 or higher is required. All other requirements for modems~~ must be met as defined in Chapter [X], "Modems."

?? For a network adapter, support is optional, rather than required, for remote new system setup capabilities. All other requirements for network communications must be met as defined in Chapter [X], "Network Communications."

Support for remote wake-up is not required to be built into mobile PCs. ~~However, CardBus implementations that support the power management event (PME) signal meets this capability. For information about PME signal definition, see *PCI Bus*~~

~~*Power Management Interface Specification for PCI to CardBus Bridge, Revision 1.0* or later.~~

~~**6.14 [DELETE] Mobile system supports hot-pluggable devices and alternative network connections**~~

Note to Reviewers: Recommendations are not include in PC 2001

~~**6.15 [DELETE]Mobile system meets Mobile Power Guidelines '99**~~

Note to Reviewers: Recommendations are not include in PC 2001

6.16 If implemented, CD or DVD drive meets Mobile PC 2001 guidelines

Mobile PC does not require a CD or DVD drive; if one is included, it must meet the requirements in Chapter X, "Storage." The mobile PC must also support booting from the drive, whether it is integrated into the platform, contained in a user exchangable bay device, or attached to the system via a dongle or other cable.

~~**6.17 If Windows 2000 is preinstalled, mobile system meets Manageability Baseline requirements**~~

~~Mobile systems that come preinstalled with Windows 2000 must comply with the following PC 2001 Manageability Baseline requirements, as defined in Chapter [X], "PC 2001 Basic Requirements":~~

~~? 3.51, "System supports WHIIG"~~

~~? 3.52, "System includes driver support for WMI"~~

~~? 3.53, "Management information service provider enabled by default"~~

6.8-6.25 [REDUNDANT]

Docking System Requirements

Mobile PC docking systems allow docking of a PC, to enhance the capabilities of the mobile PC, or to facilitate its use in a fixed work environment, such as an office or home. A docking station allows the end user to add other devices to the mobile PC system—for example, sound, network adapter, hard disks, CD drive, different display adapter, SCSI, modems, and so on.

Docking systems can support hot, warm, or cold docking. Warm docking refers to docking and undocking the mobile PC while the system is in a low power state (as defined in the ACPI 1.0 specification) but is not powered off. Hot docking refers to docking and undocking the mobile PC while the system is operating at full power and is in an active working state. Cold docking refers to docking and undocking that is done with both the PC and the docking system in an unpowered state.

Resource conflicts can occur when a mobile PC is paired with a docking system that allows users to add non-proprietary expansion devices to the system.

For a mobile PC/docking air, the system designer must ensure that the docking system is capable of arbitrating resources for conflicts that might occur if an expansion card is added to the docking station. However, the system designer does not need to add to the Mobile PC unit all of the PC 2001 resource-arbitration capabilities.

The requirements in this section apply for mobile designs that include a docking system. There is no requirement that a mobile PC must have a docking system.

Docking Definitions

This section defines the types of docking modules that interface to a mobile PC platform.

Because Port Replicators provide simple wire "pass-through" to external devices, such docks do not impose any dock-specific requirements on a PC's operating system. Port Replicators are not "software-visible". Docking stations (i.e. Mini-Docks or Full Docks) *are* software-visible, and they *do* need OS support to configure and control their internal active-electronics hardware resources.

?? **Mini-Dock:** A mini-dock provides external cable connections as an extension of the connector receptacles on the mobile PC unit. A mini-dock also incorporates some form of active electronics to create extended mobile PC platform features and functions. ~~The added active electronics might provide additional user-accessible CardBus slots, communication receptacles, or both, such as RS-232, IEEE 1284, IEEE 1394, and so on. The mini-dock does not provide user-accessible PCI slots, but might provide internal PCI expansion capabilities accessible only to the OEM.~~

~~A mini-dock does not have internal user-upgradeable capabilities for adding desktop peripherals or I/O expansion cards. Hence, a mini-dock can be considered a "sealed" docking station, where all expansion capabilities are provided using external expansion ports, so that the operating system always knows what to expect about available devices. However, this does not preclude designs that include internal components that can be upgraded by the OEM or trained service personnel.~~

?? **Full Dock:** A full dock, when interconnected with the mobile PC platform, is typically designed to extend the features and functions of the mobile PC to be equivalent to that of a desktop platform system. ~~Requirements and specifications for features and functions available when a mobile PC platform has been interconnected with a full dock are, typically, the same asthose for a desktop platform system.~~

A full dock incorporates native bus expansion slots. ~~It is user-expandable to include desktop peripherals and expansion cards. A full dock is typically larger than a port replicator or a mini-dock.~~

General Docking Requirements

PC 2001 requires that drivers for devices in a dock must fully support dynamic loading and unloading, as well as all power management and Plug and Play messages. In certain designs, some devices that are normally considered system devices can be treated as static devices.

In the case of a desktop system, static devices might not necessarily have to have their driver be capable of dynamically unloading, for example, a custom keyboard driver or custom storage driver. However, in some docking designs, such devices are sometimes "mirrored" in a docking station. Under these conditions, the driver must be able to be unloaded dynamically; otherwise, the operating system cannot stop the device, preventing a mobile ejection.

~~The methods for the following dock identification scenarios can be supported by the system BIOS, which requires a mobile system to be aware of each type of docking station and features it supports, or by the docking station itself, which could contain the ACPI table needed to differentiate the model, unique ID, and features in the dock. Either method would allow the system BIOS to pass this information to the operating system without actually having to support every conceivable combination.~~

6.26 Docking station supports PCI docking through a bridge connector

If PCI docking is implemented, the system must support docking through a bridge connector, with the actual bridge on the docking station and not on the mobile unit. The bridge can use positive or subtractive decoding. The bridge should create a new bus number for the docking-station resident expansion bus, assuring that devices behind the bridge are not on the same bus number as other devices in the system.

After a warm dock, the BIOS should not configure the bridge or any other devices in the docking station. Configuring the docking station devices is the responsibility of the operating system.

Notice that implementing delayed transactions for PCI-to-PCI docking bridges is required in ~~PCI 2.1~~PCI 2.2 or later only when certain timing conditions are not met. For PC 2001 design requirements, delayed transactions are required only when "targets cannot complete the initial data phase within the requirements of this specification," as stated in ~~PCI 2.1~~PCI 2.2 or later. Delayed transactions, which provide a performance advantage, are a hardware-related timing issue; they are not related to operating system requirements.

6.27 Docked mobile PC supports state change notification using ACPI

All docks are required to expose their components to the operating system using ACPI tables.

When a mobile PC is attached or detached ~~"docked"~~ to a docking station, mini-dock, or port replicator, specific notification must be made using ACPI methods to enable the operating system to properly change states or enumerate new devices that appear in the system. This notification must occur during a "hot" docking event or when the system returns from a warm or cold dock.

All notification events and docking control must be implemented as defined in Sections 5.6.3 and 6.3 of the ACPI 1.0 specification.

6.28 Docked mobile PC has the ability to identify the specific model of the dock

The system must be capable of uniquely identifying to the operating system a specific system configuration. Each separate system in the same model line must have a unique ID. This is to prevent the problems with current implementations that require the operating system to "cycle" different docking profiles at every docking event to try to identify what specific model of dock is attached.

6.29 Docked mobile PC has the ability to uniquely identify the dock

The system must be capable of uniquely identifying an individual dock. This allows support for users that dock laptops into differently configured docks to have different features or settings at different locations and again prevents the operating system from unnecessary enumeration of the system on docking events.

6.30 Mobile PC/docking station combination meets PC 2001 requirements

There is no requirement that a mobile PC must have or be shipped with a docking station. If a mobile PC is shipped with a docking station, the combination must meet PC2001 requirements.

Windows 2000 requires that drivers for devices in a dock must fully support dynamic loading and unloading, as well as all Windows 2000-based power management and Plug and Play messages. In certain designs, some devices that are normally considered system devices can be treated as static devices.

In the case of a desktop system, static devices might not necessarily have to have their driver be capable of dynamically unloading, for example, a custom keyboard driver or custom storage driver. However, in some docking designs, such devices are sometimes "mirrored" in a docking station. Under these conditions, the driver must be able to be unloaded dynamically; otherwise, the operating system cannot stop the device, preventing a mobile ejection.

~~However, if a mobile PC supports a docking station, manufacturers must submit the combined docking station and mobile PC for PC 2001 compatibility testing, and this combination must pass testing.~~

The docking unit must be able to power the mobile system and charge the mobile system's battery under the control of the mobile system.

Some PC 2001 requirements might apply to a mobile PC/docking station combination that do not apply to the mobile PC as a standalone unit. The intent for PC 2001 is that such requirements apply only because of facilities present in the docking station. For example, if a docking station provides graphics capabilities that substitute for the graphics capabilities of the mobile unit, the PC 2001 graphics requirements apply for the mobile PC/docking station combination when the substituted graphics component is in use. If the mobile PC is supplying all graphics capabilities, Mobile PC 2001 graphics requirements still apply.

This does not require all new PC 2001 mobiles that have docking station support automatically to have new docking station designs that are designed to meet PC 2001~~requirements. PC 2001 mobile PCs can support docking stations that have already been tested to meet earlier design guideline requirements. The combination of a PC 2001 mobile and an earlier design docking station must still be submitted for testing, and general system requirements still apply.~~requirements. The relevant requirements in this case are the following:

?? The user cannot experience resource conflicts.

?? All drivers for earlier docking stations must be updated as necessary to support the pre-installed operating system.

For example, in order for older docking stations to work properly with a PC 2001 mobile PC running Windows 2000, all drivers must be updated to support dynamic loading, Plug and Play, and power management messages. This does not imply that new features must be added, but rather that the mobile system/ operating system combination must have full control over the features in the docking station.

This exception does not imply that a new docking station can comply with a reduced set of PC 2001 requirements based on an earlier design guideline. If a docking station is a new design released during the time that this design guide is in effect, such combinations of mobile and docking station must meet all PC 2001 requirements.

6.31 Docking station meets all PC 2001 system requirements

All basic PC 2001 requirements must be met by the dock and its devices, as defined in Chapter [X], "PC 2001 Basic Requirements." These include requirements for ACPI, Plug and Play, power management, and bus and device specifications.

The docking station must meet the PC 2001 BIOS requirement for multiple adapters and multiple monitors, which allows for the graphics capabilities in the mobile unit to be fully operational (either the LCD panel or external connector) in the event that a user adds another graphics adapter to the docking station.

~~Many docking stations support VCR-style docking in which the notebook is closed when docked, so the user is prevented from accessing the notebook display. It is recommended that users not be precluded from accessing their notebook display when docked and that users have the option of simultaneously using the main display on the docking station and the notebook display.~~

Windows 2000 is designed such that all devices on a docking station (whether built in or added on) must be Plug and Play devices, either based on ACPI or a bus standard described in the PC 2001 guidelines.

~~**Note:** ISA slots are not allowed in docking stations, as defined in requirement 3.28, "System does not include ISA expansion devices or slots."~~

6.32 Mobile/docking station interface is supported using ACPI-defined mechanisms

The mobile unit must provide docking notification using mechanisms defined in the ACPI 1.0b Implementers' Guide (or later version). Non-Plug and Play devices must be enumerated, configured, and disabled using ACPI-based methods. All notification events and docking control must be implemented as defined in Sections 5 and 6 of the ACPI 1.0b~~specification (or later).~~

6.33 Mobile PC/docking station combination supports automatic resource assignment and dynamic disable capabilities

The mobile PC unit that is part of a docking system does not require all of the resource-arbitration capabilities required for expandable PC systems. However, the system as a whole must be capable of completely and dynamically disabling static onboard and add-on devices, and of freeing all the resources used by that device when the mobile unit is docked.

This requirement applies for all Plug and Play devices, but excludes fixed-resource devices such as the DMA controller, interrupt controller, and so on, as summarized in requirement 3.12, "Each bus and device meets Plug and Play specifications."

With this capability, individual devices in the mobile PC can be disabled when the unit is docked, allowing the appropriate devices in the docking station to be enabled. The system could fail if an add-on card requires resources that conflict with a device on either the mobile PC or the docking station. The mobile PC/docking station combination must be able to resolve resource conflicts among all the devices in the docking system.

This means that docking station devices must be available to replace disabled devices in the mobile PC, and these devices must meet the basic Plug and Play resource arbitration requirements for PC 2001, as described in the "PC 2001 General Device Requirements" section in Chapter [X], "PC 2001 Basic Requirements." However, it is up to the design engineer of a mobile PC/docking station combination to determine which component (mobile PC or docking station) will resolve the conflict when the mobile unit is docked.

For more information about resource arbitration when two devices such as two keyboards or two mice are present, see requirement 13.49, "Dynamic resource configuration is supported for all devices."

Note: Under Windows 2000, drive letter assignments do not change when drives are added or removed by way of a docking event. That is, all drives in the mobile PC retain their originally assigned drive letters. Designers should note this differing capability in comparison with Windows 95/98.

6.34 Docking station supports warm docking

Docking or undocking a mobile unit from a docking station must not require powering off the system and must not require a system reboot.

Removable ATA devices in the docking station and in the mobile unit are required to report changes using ACPI-based methods.

6.35 Docking system supports fail-safe docking

The system must provide a fail-safe mechanism for attaching and detaching the mobile unit. The mechanism, in combination with operating system capabilities and methods defined in Sections 6 and 5 of the ACPI 1.0a specification (or later), must ensure the following:

?? The undock button signals the user's intent to the system.

?? The user can initiate undocking through Windows-based software choices. Notice, however, that a hardware "button" must also be provided, because experience shows that users often do not find the software option and remove mobile units without operating system notification.

?? The undock button or software choice sends a signal to the operating system so that the user is warned if resources are in danger of being lost.

?? A safe-undock indicator is provided so the user can identify when it is safe to remove the mobile unit. This can be an LED or any other mechanism chosen by the vendor. If a physical mechanism automatically undocks the mobile ~~or if hot docking is supported, then~~PC, the safe-undock indicator is not required.

There is no requirement for mechanical lockout to block the user from removing the mobile unit without operating-system notification.

~~**6.36 [DELETE] Docking station includes an IEEE 1394 port**~~

Note to Reviewers: Recommendations are not include in PC 2001

6.37 If audio is implemented, docking station/mobile pair meets PC 2001 audio requirements

If audio is implemented, the docking station/mobile PC pair must meet the requirements for PC 2001 audio as defined in Chapter 11, "Audio," with additional requirements as follows:

?? The user must be able to select speakers in the mobile unit or the docking station.

   System vendors can choose to automate the process either in the docking station or the mobile PC to meet this requirement. For example, instead of offering a UI where the user can select speakers, the system manufacturer can configure the pair to automatically turn on the docking station speakers and turn off the mobile PC speakers when in the docked configuration.

   The objective of this requirement is to ensure that users can access the highest quality audio output in any given configuration. If speakers are automatically selected, the vendor should prevent multiple outputs from occurring simultaneously. If speakers are not automatically selected, then a manual selection process must be offered to the user. Additionally, the speakers should be switched off if the headphone or line-out jacks are used.

?? The docking station is not required to implement full desktop audio capabilities, but it can supplement the audio capabilities of the mobile unit.

Mini-Dock Requirements

The requirements in this section apply for any mini-dock designed for a PC 2001 mobile PC. There is no requirement that a mobile PC must have a mini-dock.

A mobile PC with a mini-dock does not need to meet the expansion card requirements and does not need to meet all the resource requirements of a mobile PC/full dock combination. ~~A mini-dock is not required to provide an undock or eject button.~~

However, some mobile PC system designs include a mini-dock that has dedicated features for networking, additional CardBus slots, a CD drive, and so on. This means that the system could have additional resource requirements to the point that all available IRQs in the system are already allocated; in this case, the CardBus slots (for example) would not have any IRQs available, rendering them useless.

~~In such cases, the mini-dock must contain devices that replace any devices in the mobile PC that do not meet the IRQ, DMA, I/O port, and memory requirements for PC 2001. This allows the operating system to disable the device on the mobile PC, to enable the corresponding device on the mini-dock, and then to~~

~~arbitrate resources among the remaining devices in the mobile unit and on the mini-dock.~~

6.38 Mini-dock supports automatic resource assignment and dynamic disable capabilities for replacement devices

A mini-dock that can accept expansion cards must contain devices that replace any devices in the mobile PC not meeting PC 2001 requirements for IRQ, DMA, I/O port, and memory resources. This allows the operating system to disable the device on the mobile PC, enable the corresponding device on the mini-dock, and arbitrate resources among the remaining devices in the mobile unit and on the mini-dock.

Devices in the system must be capable of being dynamically disabled so that the user can choose to free resources in order to allow other devices in the system to function.

6.39 Mini-dock supports warm docking

Docking or undocking a mobile unit from a mini-dock must not require powering off the system and must not require a system reboot.

Removable ATA devices in the mini-dock and the mobile unit are required to report changes using ACPI-based methods.

6.40 Mini-dock supports fail-safe docking

The system must provide a fail-safe mechanism for attaching and detaching the mobile unit. The mechanism, in combination with operating system capabilities and methods defined in Sections 5 and 6 of the ACPI 1.0a specification (or later), must ensure the following:

?? The mini-dock has an undock button that signals the user's intent to the system.

?? The user can initiate undocking through a Windows-based software choice or the hardware undock button. Either choice must cause a signal to be sent to the operating system so that the user is warned if resources are in danger of being lost.

?? A safe-undock indicator must be provided so the user can identify when it is safe to remove the mobile unit. The indicator can be an LED or any other mechanism chosen by the vendor. If a physical mechanism automatically undocks the mobile PC or if hot docking is supported, then the safe-undock indicator is not required.

There is no requirement for mechanical lockout to block the user from removing the mobile unit without operating system notification.

~~6.41 [Delete] Mini-dock includes an IEEE 1394 port [cf. 6.36]~~

Note to Reviewers: Recommendations are not include in PC 2001

~~6.42DELETE~~

PC Card ~~Socket Controller~~ Requirements

~~This section summarizes requirements and standards for socket controllers.~~

This section summarizes requirements for PC Card implementation. These requirements apply to two distinct types of PC Cards: 16-bit PC Cards, and 32-bit CardBus cards.

"Zoomed Video" (ZV) PC Cards are a unique type of PCMCIA card that uses a "Custom" interface which differs from both the 16-bit interface and from CardBus. However, ZV cards are similar to 16-bit PC Cards, and thus ZV requirements are treated under the 16-bit card section of this document.

For each of these two types of PC Cards, requirements are defined in four different implementation areas:

?? Socket controller ("bridge") requirements;

?? Host-system support requirements (such as motherboard and firmware)

?? Software requirements

?? Card requirements

Note that power-management requirements may be included in each of the preceding requirements categories, in keeping with the fact that power-management is a system-level capability. Also note that both 16-bit PC Cards and CardBus cards can be "multi-function" cards (that is, cards that include multiple devices, all of which share that card's single PC Card interface).

Each device in a multifunction PC Card—such as a CardBus card—must separately meet the power management device class specifications for its device class and be independently power managed. This means that both device A and device B on the same add-on card do not have to be idle before the devices can be power managed.

A CardBus socket can accept any of the above-mentioned PC Card types. When a CardBus socket controller is used to interface with a 16-bit PC Card, the controller is set up differently than when interfacing a CardBus card. Requirements involving use of a CardBus socket controller with 16-bit PC Cards are included in the list of CardBus requirements (rather than in 16-bit PC Card requirements).

Note to Reviewers: We are considering moving this section out of the document to a repository for well known industry standards that don't need to be repeated in this guide.

Host-System Requirements

[12.3] System maintains mapping of IRQ Routing Register bits to system interrupt vectors

The system design must maintain the mapping of the PC Card controller's IRQ Routing Register bits to system interrupt vectors. This means that when an interrupt is programmed in the controller to occur on the IRQ*x* pin, the system's IRQ routing causes the interrupt controller to generate the interrupt vector for IRQ*x* and no other IRQ.

Socket-Controller Requirements

[12.16] Socket controller complies with device class power management reference specification

~~This applies for both 16-bit PC Card-only controllers and CardBus controllers.~~

The *PC Card Controller Device Class Power Management Reference Specification, Version 1.0* or later, provides class-specific definitions of the OnNow device power states (D0–D3) for these devices. The specification also covers device functionality expected in each power state and the possible wake-up event definitions for the class, for example, whether card insertion should wake the system.

Software Requirements

[12.19] No user intervention required for correctly installing devices

The user must not be required to perform any device-installation action other than to insert disks that contain drivers and other files.

[12.20] Device is immediately functional without restarting the system

The user must be able to begin using the device without having to restart the system. Device use begins either after installation is complete or whenever the device is inserted in the system.

16-Bit PC Card Requirements

This section summarizes the Plug and Play requirements for 16-bit PC Card cards.

The Windows operating system determines what type of card is plugged into the PC Card socket by examining the tuples on the card. For Plug and Play functionality, 16-bit PC Card I/O cards must support a set of required

information and configuration tuples. The PCMCIA bus enumerator uses these tuples to identify the card, load the correct device driver, and indicate all possible configurations to the Plug and Play configuration manager. The operating system then dynamically assigns a valid configuration based on this information.

[12.17] 16-bit PC Card cards implement power-related events using ReqAttn bit and #STSCHG mechanism

Any 16-bit PC Card card that is capable of signaling a wake-up event to the system, as defined in the device class power management reference specification for its class, must implement the ReqAttn bit and its associated enable bit in the Extended Status register, and must signal on the #STSCHG line.

Socket-Controller Requirements

[12.2] Controller supports industry-standard ExCA register set

The built-in software supporting 16-bit PC Card cards in Windows includes drivers for the industry-standard Exchangeable Card Architecture-compatible (ExCA-compatible) socket controllers. To be compatible with these drivers, socket-controller implementations must support the industry-standard ExCA base register set.

Notice that some controllers do not fully implement the register set and therefore are incompatible. Also, some controllers implement extended registers or enhancements. The built-in Windows drivers do not exploit these features, even though the controller might be compatible.

Software Requirements

[12.21] ZV-compatible PC Card driver uses DirectDraw LVE

ZV-compatible PC Card drivers must use software interfaces based on 32-bit DirectDraw Live Video Extensions (LVE) in order to configure the graphics controller to receive video input using the ZV port. This includes programming the graphics controller to configure the format of the video data, its location on screen, and so on. LVE is part of DirectX 3.0 and later versions.

ZV card device drivers must handle dynamic graphics state changes, such as resolution changes, color depth changes, and switching to and from full-screen MS-DOS–based applications.

Card Requirements

[12.10] Card supports required I/O card tuples

The following items must be implemented for any 16-bit PC Card I/O card that connects to a PC2001 system:

?? The 16-bit PC Card card must contain:

- The device information tuple (CISTPL_DEVICE, 01h for cards capable of 5 V operation or CISTPL_DEVICE_0C, 1Ch for cards capable of 3.3 V operation).
- The Level 1 (L1) version/product information tuple (CISTPL_VERS_1, 15h).
- The configuration tuple (CISTPL_CONFIG, 1Ah).
- The configuration table entry tuple (CISTPL_CFTABLE_ENTRY, 1Bh).

- A 16-bit PC Card card with more than 64 MB Common Memory must contain the extended device information tuple (CISTPL_EXTDEVICE, 09h).
- The L1 version/product information tuple must contain the product name and manufacturer name in the product information string (TPLLV1_INFO, byte 4).
- The product name and manufacturer name in the L1 version/product information tuple must be composed only of ASCII characters greater than ASCII 20h and less than ASCII 7Fh.

Windows uses the information contained in the required and recommended tuples to create a unique device ID for the card and to assimilate configuration information for the device. Windows uses the device configuration tuples to determine the general characteristics of the card.

Required I/O Card Tuples

Tuple ID	Tuple code	Description and comments
01h	CISTPL_DEVICE	Device information (common memory). For non-memory cards, this tuple must be present, but the device type will be NULL.
15h	CISTPL_VERS_1	L1 version/product information strings: Product information, Product name, Product number, Other manufacturer information
1Ah	CISTPL_CONF	Configuration. Indicates the location of configuration registers and registers present.
1Bh	CISTPL_CE	Configuration table entry. Appropriate configuration requirements for I/O space, interrupts, memory, and so on should be specified.
20h	CISTPL_MANFID	Manufacturer ID. Card manufacturer ID code. Defines manufacturer for this card.
21h	CISTPL_FUNCID	Function ID. Provides function information about the card. Also includes system initialization information.

The device information tuple provides information about the memory devices used in the card's common memory space. The device type, size, and speed are used to configure the socket for efficient access to the card. This tuple must be present on 16-bit PC Card I/O cards, but the device type must be NULL.

The L1 version/product information tuple contains human-readable information about the product and its manufacturer. This information is intended to be displayed to the user where necessary. Windows uses the information contained in the product information string and product name string to construct the device ID for that card. It also scans through the tuple, starting at the very beginning and continuing to the end of the product name string.

The information gathered from the L1 version/product information tuple is used to construct the unique device ID. Because the optional third and fourth strings in the tuple are not used in the unique ID, devices that require unique numbers on each card can use these strings to store that information.

The configuration tuple tells the software where to locate the configuration registers that program the card's configuration, as well as which registers are present on the card.

Each configuration table entry tuple completely describes one valid configuration in which the card can operate. Each entry describes power, timing, I/O space, interrupt, and memory space requirements for the given configuration. Configuration software selects one of these configurations for the card based on the resources currently available in the system.

The manufacturer ID tuple (CISTPL_MANFID, 20h) and the function ID tuple (CISTPL_FUNCID, 21h) add extra flexibility to a PC Card that connects to the PC:

?? The manufacturer ID tuple provides unique information about the card manufacturer. This code is registered with PCMCIA. Windows uses the manufacturer ID tuple as one source for creating a 16-bit CRC used in the construction of the device ID.

?? The function ID tuple provides information about the class of device or what function the card provides, for example, memory, modem, disk, and so on. This information helps the software perform necessary installation tasks and locate compatible drivers. Although it is not required to make this determination, Windows uses the function ID tuple internally to determine what type of device is on the PC Card.

[12.11] Configuration table entry tuples listed in priority order

Configuration table entry tuples are placed in the preferred order for configuring the device. Windows processes the tuples in the order they are placed in the Card Information Structure (CIS). From these tuples, Windows creates a logical configuration in this order and prioritizes them in the same order. Notice that for multiple voltage cards, the voltage policy is to prioritize 3.3-volt configurations,

if they are supported by the system, over 5-volt configurations, regardless of the order of the configuration table entry tuples (CISTPL_CFTABLE_ENTRY).

[12.12] Card specifies maximum configuration options

Many older PC Cards specified fixed configurations in order to address compatibility with existing software. However, this is not the intended use for tuples; the configuration software is responsible for compatibility. The tuples must be used only to describe its maximum configurability, ruling out configurations not supported by the hardware.

If fixed configurations must be provided for an operating system other than Windows, there must be one or more entries that specify the maximum configurability that the hardware can handle. An example of "maximum configurability" is to specify "any IRQ" rather than only IRQ 3 or IRQ 4.

CardBus Requirements

This section summarizes the Plug and Play requirements for CardBus cards. CardBus was designed to gain the benefits of PCI in a PC Card format. Consistent with this goal, Windows support for CardBus places specific requirements on CardBus cards.

[12.18] CardBus controllers and cards implement PCI/CardBus power management specifications

PCI-to-CardBus bridges and CardBus cards must comply with the requirements defined in *Section 3 (PCI Bus Power Management Interface Specification for PCI-to-CardBus Bridges) of the PC Card Standard, release 7* or later. This Specification describes the CardBus power-management interface hardware, as well as proper software use of these hardware mechanisms.

The CardBus card must use the CSTSCHG pin to signal wake-up events because there is no PME# pin on the CardBus interface, and the CardBus card must use PME_EN in the card's Configuration Space to enable wake-up events. Specifically, setting the PME_EN bit in the card's Configuration Space must provide the same behavior as setting both the GWAK and WKUP bits in the card's Function Event Mask register.

Socket-Controller Requirements

[12.4] IRQ connections can be determined by using the 0805 register

Windows uses the 0805 register on CardBus controllers to determine which ISA IRQs are connected to the controller. This register must select (drive low when the IRQ is asserted) the corresponding ISA IRQ when programmed with a value. It must deselect the IRQ (float high) when programmed at zero (0). This behavior must be achieved without requiring the operating system to program any non-standard registers.

Note to Reviewers: This guideline might be adjusted due to V7 of the PC Card Standard.

[12.5] CardBus controllers support both ISA and PCI interrupts

PC Card software dynamically configures the bridge to use ISA interrupts for 16-bit PC Card cards and to use Peripheral Component Interface (PCI) interrupts for CardBus cards. As defined in requirement 12.5, "IRQ connections can be determined by using the 0805 register," and requirement 12.4, "System maintains mapping of IRQ Routing Register bits to system interrupt vectors," CardBus controllers must maintain mapping of IRQ routing. Also, notice that systems implementing CardBus controllers must fully support PCI 2.2 as well as additional PCI requirements for IRQ routing as described in requirement X.XX, "Interrupt routing is supported using ACPI," and requirement X.XX, "BIOS does not configure I/O systems to share PCI interrupts."

To ensure that the Windows operating system can correctly assign ISA IRQs to 16-bit PC Cards, CardBus controllers that have parallel ISA IRQ mode must have all ISA IRQs pins, except IRQ 0 (timer), 1 (keyboard), 6 (floppy), 8 (CMOS), 13 (math coprocessor). System vendors using parallel ISA IRQ mode always should connect ISA IRQs 3, 4, 5, 7, 9, 10, 11, 12, 14, 15 and not cross wire them. Vendors using serialized IRQ mode only need to connect the serial IRQ pin, and the ISA IRQ information will be sent to the PCI chip set serially; the ISA IRQ information can specify any of IRQ 0–15.

If wake-from-D3cold is to be implemented in a platform, the following is required:

?? Associated CardBus controller must support PME# assertion from D3cold.

?? Associated socket must supply Vaux power of up to 200mA at 3.3v to an attached card while the card is in D3cold.

This requirement must be independently met by each enabled D3cold-wake-capable CardBus socket in the system, as defined in the Host System chapter of the PC Card standard, Version 7.

[12.6] System supports industry-standard definition for CardBus bridges

Systems must support the definition in the *PC Card Standard Release 7 (or later) PC Card Host System Specification, PCI-to-CardBus Bridge Register Description* for CardBus controllers (PCI-to-CardBus bridges). This definition includes a common PCI Configuration Space header assigned the Header Type field value of 82h.

Windows supports this specification. Any controller features that are not part of this specification will not be used in standard drivers. The BIOS is responsible for any hardware initialization or setup required to make the controller comply with this specification, or with other requirements listed in this chapter.

Because CardBus host controllers are PCI bus bridges, they will be supported (enumerated and configured) by the PCI software in Windows in the same manner as other PCI bus bridges. For more information, see requirement X.X, "System uses standard method to close BAR windows on nonsubtractive decode PCI bridges."

[12.8] CardBus controllers do not share writable PCI Configuration Space bits

CardBus controllers are multifunction PCI devices, and Windows treats each function as an independent device. As such, there can be no sharing between functions of writable PCI Configuration Space bits, such as the Command register.

Notice that the 16-bit PC Card interface legacy-mode BAR (offset 44h in the Type 2 PCI header) is the only exception to this requirement. This BAR must be shared between the two functions in order to be compatible with the ExCA programming model.

[12.9] Each 16-bit PC Card memory window in CardBus controller has it own page register

For complete flexibility and support of typical configurations, CardBus controllers must support the independent location of legacy mode memory windows anywhere in the full system address space as recommended in the *PC Card Standard Release 7 (or later) PC Card Host System Specification, PCI-to-CardBus Bridge Register* specification.

Controllers that share a single page register among all 16-bit PC Card memory windows require that all 16-bit PC Card memory windows must be located within the same 16-MB block. This is often not possible with typical (16 MB) DRAM and bridge (positive-decode) configurations. The result is disabled cards.

Host-System Requirements

[12.7] BIOS initializes CardBus controller in 82365-compatible mode and supports backward compatibility

When 82365 compatible modes are implemented, CardBus controllers are enumerated and configured in the same way as other PCI bus bridges. The PCI bus bridge support in Windows is based on requirements for PCI interrupt routing and bridge-window configuration. Therefore, full compliance with the latest PCI specifications is a requirement for CardBus support. See the PCI section of Chapter 9, "Buses and Interfaces."

There are steps the BIOS can take to achieve backward compatibility with Windows. Specifically, the BIOS can initialize the CardBus controller in Intel 82365-compatible mode and report it as device "PNP0E03, Intel 82365-

compatible CardBus controller." The requirements for BIOS POST time (CardBus controller ConfigSpace initialization) are as follows:

?? Command register (offset 0x04) set to 0x07 (IOSpaceEnable, MemSpaceEnable, BusMasterEnable).

?? RegisterBaseAddress (offset 0x10) set to 0. If support for other environments is needed, such as Windows 3.1 or MS-DOS®, some other value can be set.

?? All memory and I/O windows (offset 0x1c–0x38) set to 0.

?? Interrupt Line register (offset 0x3c) set to 0xff (no IRQ assigned). If support for other environments is needed, such as Windows 3.1 or MS-DOS, an assigned IRQ line can be set. Notice, however, that this register must be set to 0xff at the time that the device is disabled by the operating system, and then set into CardBus mode. More information about BIOS enumeration is presented later in this requirement.

?? Other controller-specific initialization as required to put the controller in 82365-compatible legacy mode.

This puts the CardBus controller into legacy mode where the Windows Socket Services driver can access it as an Intel PC Card Interface-Controller–compatible (PCIC-compatible) controller at an I/O address, for example, 0x3e0.

Notice that the BIOS must be at least PCI 2.2-compliant and must support the $PIR Interrupt Routing Table. The $PIR table must return the necessary PCI IRQ routing information, including the routing information for the CardBus controller. In general, if the CardBus controller is on the system board, there must be a slot routing entry for it in the table. If the CardBus controller is a PCI add-on card, there must be routing information entries for each PCI slot in the system.

During Plug and Play BIOS enumeration, the BIOS should report the CardBus controller as *pnp0e03 with a compatible ID of *pnp0e00 and the I/O resource of two ports, for example, 0x3e0–0x3e1.

For more information, see the white paper on CardBus host controllers and Windows compatibility at http://www.microsoft.com/hwdev/cardbus/.

Software Requirements

[12.15] CardBus card implements required and recommended tuples

For CardBus, Windows also requires the same set of card tuples recommended in the PC Card guidelines, as summarized in the following table.

Required CardBus Tuples

Tuple ID	Tuple code	Comments
04h	CISTPL_CONFIG_CB	—
05h	CISTPL_CFTABLE_ENTRY_	—

	CB	
07h	CISTPL_BAR	—
13h	CISTPL_LINKTARGET	Required as first tuple in PC Card standard.
15h	CISTPL_VERS_1	—
20h	CISTPL_MANFID	—
FFh	CISTPL_END	Required as end-of-chain tuple in PC Card standard.
21h	CISTPL_FUNCID	Recommended in PC Card standard; required for PC2001.

[12.22] 16-bit PC Card card driver supports sharing of level-mode interrupts

CardBus systems support both 16-bit PC Card cards and CardBus cards. In this environment, interrupt sharing becomes an issue because CardBus controllers can use PCI interrupts, which are level-sensitive and sharable. To help alleviate interrupt limitations in CardBus systems, Windows operating systems can take advantage of PCI interrupt-sharing capabilities.

In cases where no ISA IRQs are available to a 16-bit PC Card-16 card in a CardBus controller, the operating system will assign a PCI interrupt to the card. Also, 16-bit PC Card-16 card drivers must “hook” the interrupt, whether it is sharable or not, before its hardware generates any interrupts.

~~See also requirement X.XX, “BIOS configures boot device IRQ and writes to the interrupt line register.”~~

Card Requirements

[12.13] Configuration Space meets Common Silicon Guidelines

The Common Silicon Guidelines are defined in Section 2.1 of the *PC Card Standard Guidelines, Volume 10.*

The standard for CardBus defines a PCI “Type-2” Configuration Space that is defined in Section 4.5 of Volume 11 (*PC Card Host System Specification*) of the *PC Card Standard*. The Type-2 CardBus-bridge PCI header structure was defined to be as similar to the Type-1 (PCI-to-PCI bridge) header as possible. Type-2 and Type-1 PCI headers differ only in that the Type-2 header allows 4-byte resolution in I/O Base and Limit registers, while the Type-1 header supports a coarser 4K resolution for these registers.

CardBus cards include normal Type-0 PCI headers, with certain provisions. The quadword register located at 0x28 is used as a pointer to the CardBus Card Information Structure (CIS). CardBus cards must also implement certain

Command and Status Register fields that are optional for PCI devices. CardBus cards must also provide a Memory Base-Address register (BAR) for every I/O BAR provided (so that I/O windows can be memory-mapped).

Section 2.1.3.4 of Volume 10 (*Guidelines*) of the *PC Card Standard* Release 7 (or later versions) details the Common Silicon Guidelines to which CardBus cards must adhere

To maintain compatibility with existing PCI system software and drivers for PC2001, Windows will support only CardBus cards whose Configuration Space is designed to meet the Common Silicon Guidelines. This is a requirement because CardBus configuration is performed by the PCI software, which can deal with all aspects of PCI topology configuration, including bridging. Without the allocated fields, the cards cannot be fully treated as PCI devices and cannot be supported under Windows.

The required allocated fields are listed in the following table.

Required Allocated Fields

Field	Description and comments
Vendor ID	This read-only field contains a unique ID (in PCI space) for the card manufacturer. The PCI SIG allocates unique IDs.
Device ID Revision ID	These read-only fields are vendor-assigned values that uniquely identify the device (among all vendors of PCI or CardBus products).
Class Code	This read-only field is defined in PCI 2.2. It describes what type of device the card is.
Max_Lat Min_Gnt	These read-only fields specify the desired settings for Latency Timer values according to PCI 2.2. A value of 0 indicates the device has no major requirements for the settings of Latency Timers.
Interrupt Line	This register must be read-write and must not be connected to anything, just as on PCI cards. This register is used to store the current IRQ routing for the device.

[12.14] RESERVED fields comply with PCI 2.2

The CardBus specification also lists two RESERVED fields (offset 2C in the Configuration Space), which have since been defined in PCI 2.2. These fields are also required on CardBus cards for Windows compatibility.

Required RESERVED Fields

Field	Description
Subsystem ID	If different from Device ID
Subsystem Vendor ID	If different from Vendor ID

Checklist for Mobile

6.1 Mobile PC performance meets Mobile PC 2001 minimum requirements
6.2 Mobile PC supports Smart Battery or ACPI Control Method battery
6.4 Mobile PC connections use icons plus keyed or shrouded connectors
6.5 Mobile PC includes one USB port
6.6 [REDUNDANT] USB-connected device does not maintain fully on power state
[6.7] If implemented, Mobile PC includes compliant IEEE 1394
6.8 Mobile PC includes CardBus
6.9 Mobile PC keyboard and pointing device meet PC 2001 requirements
6.10 [MOVED] Mobile PC includes IR devices compliant with IrDA specifications
6.11 Mobile PC includes support for installing the operating system
[NEW.6.101] Mobile PC has integrated display
[NEW.6.107] Mobile PC provides PC 2001 graphics capabilities
[NEW.6.104] If implemented, external video connector meets Mobile PC requirements
[NEW.6.105] If implemented, TV output meets Mobile PC requirements
6.12 [REDUNDANT] Mobile PC includes audio that meets Mobile PC 2001 audio requirements
[NEW.6.106] Mobile PC includes PC2001 hard disk as primary boot device
6.13 Communications capabilities meet Mobile PC 2001 guidelines

6.16 If implemented, CD or DVD drive meets Mobile PC 2001 guidelines
6.8-6.25 [REDUNDANT]
6.26 Docking station supports PCI docking through a bridge connector
6.27 Docked mobile PC supports state change notification using ACPI
6.28 Docked mobile PC has the ability to identify the specific model of the dock
6.29 Docked mobile PC has the ability to uniquely identify the dock
6.30 Mobile PC/docking station combination meets PC 2001 requirements
6.31 Docking station meets all PC 2001 system requirements
6.32 Mobile/docking station interface is supported using ACPI-defined mechanisms
6.33 Mobile PC/docking station combination supports automatic resource assignment and dynamic disable capabilities
6.34 Docking station supports warm docking
6.35 Docking system supports fail-safe docking
6.37 If audio is implemented, docking station/mobile pair meets PC 2001 audio requirements
6.38 Mini-dock supports automatic resource assignment and dynamic disable capabilities for replacement devices
6.39 Mini-dock supports warm docking
6.40 Mini-dock supports fail-safe docking

[12.3] System maintains mapping of IRQ Routing Register bits to system interrupt vectors
[12.16] Socket controller complies with device class power management reference specification
[12.19] No user intervention required for correctly installing devices
[12.20] Device is immediately functional without restarting the system
[12.17] 16-bit PC Card cards implement power-related events using ReqAttn bit and #STSCHG mechanism

[12.2] Controller supports industry-standard ExCA register set

[12.21] ZV-compatible PC Card driver uses DirectDraw LVE

[12.10] Card supports required I/O card tuples

[12.11] Configuration table entry tuples listed in priority order

[12.12] Card specifies maximum configuration options

[12.18] CardBus controllers and cards implement PCI/CardBus power management specifications

[12.4] IRQ connections can be determined by using the 0805 register

[12.5] CardBus controllers support both ISA and PCI interrupts

[12.6] System supports industry-standard definition for CardBus bridges

[12.8] CardBus controllers do not share writable PCI Configuration Space bits

[12.9] Each 16-bit PC Card memory window in CardBus controller has it own page register

[12.7] BIOS initializes CardBus controller in 82365-compatible mode and supports backward compatibility

[12.15] CardBus card implements required and recommended tuples

[12.22] 16-bit PC Card card driver supports sharing of level-mode interrupts

[12.13] Configuration Space meets Common Silicon Guidelines

[12.14] RESERVED fields comply with PCI 2.2

CHAPTER 7

Easy PC Systems

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 11:47 AM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Easy PC Platform Architecture

Note to Reviewers: Industry will review this material through a separate and open review process in parallel with the review of the system design guide. Registered reviewers will be informed of the availability of all interim drafts of the "Easy PC Requirements" chapter. If this material has been through a full industry review by the 0.7 draft cutoff, this chapter will be considered for incorporation into the version 0.7 draft of this guide.

CHAPTER 8

Buses and Interfaces

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 11:50 AM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

USB

This section presents the requirements for Universal Serial Bus (USB)

USB provides an expandable, hot-pluggable Plug and Play serial interface that ensures a standard, low-cost socket for adding external peripheral devices ranging from interactive HID devices such as joysticks and pointing devices to isochronous devices such as telephony, audio, and imaging devices. USB allows

cascading hubs that can be integrated into desktop devices, such as monitors and keyboards.

USB is required on all PC 2001 systems~~., and migration of I/O devices from legacy ports to USB is recommended. In particular, the joystick, pointing device, and keyboard devices that ship with PC systems should be USB.~~

Any device that plugs into a USB port is considered a USB device and must comply with the requirements defined in these guidelines. If the device provides the capabilities of one or more functions or it provides a hub to the host, it must comply with the requirements in this chapter.

~~Manufacturers should ensure that their USB devices are tested at the compatibility workshops provided by the USB Implementers Forum.~~

USB Core Requirements

This section covers guidelines for the Universal Serial Bus (USB) specifications 1.1 and 2.0.

[7.1] ~~System includes~~ USB controllers and devices comply with ~~two~~four USB specifications ~~ports, minimum~~

Note to Reviewers: Please supply feedback on this requirement.

~~USB must be included on all PC 99~~PC 2001 ~~system types.~~

~~*Mobile PC Note*~~

~~At least two~~four ~~USB ports are required for every system type except Mobile PC, which must include at least one USB port.~~ USB support must be provided for the full bandwidth specified in the *USB Specification, Version 1.1*. If a USB port supports USB 2.0, then it must comply with the *USB Specification, Version 2.0.* ~~The requirement for four ports can be provided with an external hub if the hub is bundled with the system.~~

When a system has more than one host controller, each host controller must provide full bandwidth and isochronous support. Host controllers must be located on the PCI bus (or equivalent) to meet this requirement.

[7.2] Systems include BIOS support for USB keyboards and hubs

PC 2001 systems, except those with captive keyboards, such as a mobile PC system, must have BIOS support for USB keyboards and hubs. This support must provide the ability for the user to enter the BIOS setup utility and also provide enough functionality to install and boot a USB-aware operating system. USB keyboards built as standalone devices, part of a composite device, or part of a compound device must all be recognized and usable. The BIOS is required to support keyboards behind at least one level of external hubs.

For systems with multiple USB host controllers, BIOS support for USB keyboards and hubs is required for all host controllers that are integrated on the motherboard (that is, not add-on cards).

[7.3] All USB system hardware, hubs, and devices comply with USB ~~1. 0~~1.1 specification

All USB system hardware must comply with *USB Specification, ~~Version 1.0;~~Version 1.1* or later~~and should comply with USB Specification, Version 1.1.~~. If a USB hub or device supports USB 2.0, then it must comply with the *USB Specification, Version 2.0.* Compliance with the USB specification ensures that USB hardware has complete Plug and Play capabilities and is implemented in a standard way. Compliance with this requirement is demonstrated on the compliance process of the USB Implementers Forum.

~~For example, on any system with USB capabilities, a user must be able to dynamically attach any USB peripheral to any USB connector. The operating system should automatically recognize it, load and initialize the appropriate drivers, and make the device available for use.~~

All USB devices (which includes hubs) must comply with *USB Specification, Version 1.1* or better. Compliance with the USB specification ensures that USB hardware has complete Plug and Play capabilities and is implemented in a standard way.

[7.4] [REDUNDANT] Connections use USB icon

Note to Reviewers: This is a basic PC 2001 requirement.

[7.5] USB devices and drivers support maximum flexibility of hardware interface options

Device and driver designs must provide maximum flexibility for interface options so that the operating system or other resource manager can coordinate user preferences, allowing multiple devices and applications simultaneously.

?? 7.5.1. Devices and drivers provide multiple alternate settings. Devices and drivers must provide multiple alternate settings for each interface where any alternate setting consumes isochronous bandwidth.

?? 7.5.2. Devices and drivers must not use isochronous bandwidth for alternate setting 0. Devices must consume bandwidth only when the devices are being used.

[7.6] USB host controller meets ~~either~~ OpenHCI or UHCI~~, or USB 1.1 HC~~ specification

The host controller providing USB1.1 functionality must comply with the specifications for either *Open Host Controller Interface* (OpenHCI), published by Compaq, Microsoft, and National Semiconductor, or *Universal HCI* (UHCI), published by Intel. ~~Hardware manufacturers who design to one of these~~

~~specifications are not required to provide an additional device driver for their host controller under the Windows or Windows NT Workstation operating systems. Multiple OpenHCI and UHCI USB controllers are supported concurrently by the operating system.~~

[7.7] USB host controller can wake the system

The USB host controller must support wake-up capabilities from S1, S2 and S3 states. ~~S1 or S2. Supporting wake-up from the S3 state is recommended. Notice that if wake-up from the S2 state is supported, wake-up from the S1 state must also be supported. Similarly, if wake-up from the S3 state is supported, wake-up from the S1 and S2 states must be supported.~~

If the system contains multiple USB host controllers, ~~only one is~~ all host controllers integrated on the motherboard (that is, not add-on cards) are required to support wake-up from S1, S2, and S3. ~~capability, although it is recommended that all host controllers support wake-up capability.~~

[7.8] [REDUNDANT] USB hubs comply with USB 1.1 or specifications

Note to Reviewers: This item is now defined in requirement 7.3.

[7.9] All hubs must be self-powered except hubs integrated into USB keyboards ~~Bus-powered USB hubs provide ports that can be individually power switched~~

To minimize USB power consumption requirements, bus-powered hubs must provide ports that can be individually power switched. ~~This contributes to the goal of reducing overall system power consumption. It is especially important in mobile environments, where power consumption must be absolutely controlled when the system is on battery power. Furthermore, if a bus-powered hub is implemented in a USB keyboard, that hub must provide ports that are individually power-switched.~~

[7.10] Systems and USB devices comply with USB power management requirements

PC 2001 systems and devices must comply with the power management requirements in the *USB Specification, Version ~~1.0~~1.1* or later.

In addition, all devices must comply with the Interface Power Management feature in the *USB Common Class Specification, Revision ~~1.0~~1.1* or later.

[7.11] USB devices meet requirements in related USB device class specification

A USB peripheral that fits into one of the USB device class definitions must comply with the related USB device class specification. USB class drivers in the operating system are implemented to support devices that comply with the particular device class specification.

Class driver extensions and WDM support provided in Windows 98 and Windows 2000 allow IHVs to innovate and differentiate their products while still meeting class compliance in their base operational modes.

Devices can use the generic class drivers provided with the operating system, or manufacturers can create drivers or WDM minidrivers, depending on the device class, to exploit any additional unique hardware features.

[NEW.8.101] USB devices install without pre-loading software or drivers and without rebooting the system

For example, a user must not be required to install software before dynamically attaching a USB device. Instead, the user must be able to dynamically attach the USB device, and then load the software/drivers in response to the operating system detecting the newly attached device. ~~on any system with USB capabilities, a user must be able to dynamically attach any USB peripheral to any USB connector. The operating system can then automatically recognize it, load, and initialize the appropriate drivers, and make the device available for use.~~

USB Design for Mobile PCs

This section addresses the unique design issues for USB for Mobile PCs.

[6.5] Mobile PC includes at least one USB port

Note to Reviewers: A future draft of the chapter will address issues for when separate host interfaces are present in the mobile platform and in the dock (on dock-side PCI)

For mobile PCs, at least one USB port must be built into the PC, not provided solely by docking stations, although these units can provide extra USB connectors. This USB port can be either a high-power or low-power port, or it can be dynamically configurable at the discretion of the OEM, as provided for by Section 7 of the USB 1.1 specification.

Mobile systems are **not** required to meet the requirement for the USB host controller to be able to wake the system from S3 state, as defined in requirement [3.2], “System design meets ACPI 1.0b specification (or later) and PC 2001 requirements.”

Mobile systems that have built-in keyboards are **not** required to include BIOS support for USB keyboards and hubs as defined in requirement [3.5], “BIOS meets PC 2001 requirements for boot support.”

[6.6] For mobile PC, USB-connected internal device does not maintain fully on power state

An internal device that connects to the Mobile PC using USB must not continually maintain the system in a fully on power state. Such a device will override system power-management settings that control power-saving modes to protect battery

life. When any USB device is connected but not active, the driver must allow system power management to suspend the Mobile PC.

IEEE 1394

This section summarizes PC 2001 design requirements for PC platforms designed with one or more integrated IEEE 1394 nodes.

Core Architecture for IEEE 1394 under Windows

Windows 98 and Windows 2000 provide an IEEE 1394 bus driver. A driver for a device that connects to the IEEE 1394 bus sits on top of the IEEE 1394 driver stack. The driver communicates to the device by sending IRPs to the IEEE 1394 bus driver, which the operating system provides as 1394bus.sys. The port driver provides a hardware-independent interface to the IEEE 1394 bus. The port driver handles some IRPs, and some it forwards to the port driver for the motherboard's host controller. Microsoft provides a standard port driver for host controllers that satisfy the Open Host Controller Interface specification, Ohci1394.sys.

Base-level support for IEEE 1394 audio/video (A/V) devices is provided in Windows 98 and Window 2000 through the WDM Stream class, which supports components such as DVD decoders, MPEG decoders, video decoders, tuners, and audio codecs.

The WDM Stream class supports a uniform model for standard and custom data types, following the kernel streaming conventions described in the Windows 2000 DDK to support data transfer between kernel drivers without requiring a transition to user mode.

Support for IEEE 1394 hard disks, CD-ROM drives, DVD drives, printers, and scanners is implemented through the Serial Bus Protocol (SBP-2) class driver, which communicates through the SBP-2 port driver.

For details about the architecture and driver implementation for devices that use the IEEE 1394 bus, see "Part 6: IEEE 1394 Drivers" in the "Kernel Mode Drivers Design Guide" of the Microsoft Windows 2000 DDK (online at http://www.microsoft.com/DDK/DDKdocs/Win2k/1394-design_17dz.htm).

IEEE 1394 Basic Requirements

The following is a summary of the IEEE 1394 design considerations that must be followed if IEEE 1394 is included on a system:~~related to PC systems, as addressed in this chapter:~~

?? Compliance with IEEE 1394 standards, specifically IEEE 1394-1995 and its supplements IEEE 1394a-2000 and IEEE P1394b

?? Support for the 1394 Open Host Controller Interface (OpenHCI)~~, specifically OHCI Revision 1.1, available on the web at http://developer.intel.com/technology/1394/specs.htm~~

?? Plug and Play support for device configuration, control and status registers (CSRs), connectors and cabling, and connection fault handling

?? Cable power distribution, including requirements for source devices, sink devices, self-powered devices, and their applicable CSRs

?? Device power management, CSRs, and soft-power protocols

~~The following is a summary of the IEEE 1394 design considerations related to PC systems, as addressed in this chapter:~~

~~? Compliance with IEEE 1394 standards, specifically IEEE 1394-1995 and IEEE P1394.a~~

~~? Support for the 1394 Open Host Controller Interface (OpenHCI) specification for controllers, specifically OHCI Revision 1.0~~

~~? Plug and Play support for device configuration, control and status registers (CSRs), connectors and cabling, and connection fault handling~~

~~? Cable power distribution, including requirements for source devices, sink devices, self-powered devices, and supporting CSRs~~

~~? Device power management, CSRs, and soft-power protocols~~

?? ~~Device command protocols for audio, video imaging, still imaging, and storage device classes~~

This section defines the basic PC 2001 guidelines for implementing IEEE 1394.

[8.1] Systems implementing IEEE 1394 support mandatory features in IEEE ~~P~~1394~~a~~ standards

Systems that support IEEE 1394 features and interconnectivity designs that interface to the IEEE 1394 bus must support the industry standards and its supplements as they apply to internal and external devices.

?? **[8.1.1]** Systems must provide IEEE 1394-1995/1394a interconnectivity

All systems must support the following industry standards and their supplements:

?? IEEE 1394a-2000 supplement to IEEE 1394-1995
http://standards.ieee.org/catalog/ordering.html

?? IEEE 1394-1995 Standard for a High Performance Serial Bus
http://standards.ieee.org/catalog/ordering.html

?? IEEE 1212r-2000
http://standards.ieee.org/catalog/ordering.html

?? ANSI NCITS 3.25-1998 (SBP2)
http://www.cssinfo.com/ncits.html

?? 1394 Trade Association Power Specification (all components)
http://www.1394-pcwg.org

?? Plug-and-Play Design Specification for IEEE 1394
http://www.microsoft.com/hwdev/1394
http://www.microsoft.com/hwdev/onnow.htm

~~designs that interface to the IEEE 1394 bus must support the following industry standards and supplemental specifications:~~

~~Note to Reviewers: A future draft will explain the important scope of 1394b-2000 and its relationship to the 1394-1995 spec~~

~~? IEEE IEEE 1394a-1999, an amendment to IEEE 1394-1995~~

~~? IEEE 1394-1995 Standard for a High Performance Serial Bus~~

~~? IEEE 1212r-2000~~

~~? ANSI NCITS 3.25-1998 (SBP2)~~

~~? 1394 Trade Association Power Specification (all components)~~

~~? Plug-and-Play Design Specification for IEEE 1394 (http://www.microsoft.com/hwdev/1394/~~

?? **[8.1.2]** Systems implementing IEEE 1394 internal devices support mandatory features in the IEEE P1394b supplement to IEEE 1394-1995

If internal IEEE 1394 devices are implemented, the system must support IEEE P1394b (http://standards.ieee.org/catalog/ordering.html). This requirement does not supersede the required interconnectivity to 1394-1995/1394a devices, if externally accessible sockets are provided on the system.

System designers may incorporate only internal 1394 devices. For example, a system could provide an internal 1394 DVD device without providing any external interconnect to 1394. If, however, that same system provides externally accessible 1394 sockets, support must be provided for connecting a 1394-1995/1394a device to that socket.

[8.2] Host controller~~s s~~ support mandatory components of~~comply with~~ 1394 OpenHCI 1.1 ~~for IEEE 1394~~

Host controllers must implement the mandatory features of 1394 OHCI Revision 1.1, including host notification of a PHY LinkOn event, Dual Buffer Mode enhancements, ack_tardy processing, SCLK failure detection, Skip Processing enhancements, and Block Read Request handling.

PCI 1.1 Power Management is an implementation option for OHCI 1.1, however, IEEE 1394 host controllers used on PC 2001 systems must provide support for PCI 1.1 Power Management, including power states D0, D1, D2, and D3.

Host controllers must support IEEE 1394b-2000 features, for example, B.O.S.S.

[8.3] [REDUNDANT] OpenHCI controllers and devices support advances defined in IEEE 1394a

[8.4] Host controller supports minimum peak data rates, as specified in the applicable IEEE 1394 standards~~Host supports peak data rate of 400 Mb/s, minimum~~

Host controllers must support the highest data rate of the PHY they connect to. A system that uses a PHY for ports available only within the system must support data rates of S400-Mb/s and S800 Mb/s as specified in IEEE P1394b. A system that uses a PHY for ports available only for external access must support S100-Mb/s, S200-Mb/s, and S400-Mb/s data rates as specified in IEEE 1394-1995 and IEEE 1394a-2000. A system that uses a PHY for ports available for internal system devices and external access must support S400-Mb/s and S800 Mb/s data rates as specified in IEEE P1394b, as well as S100-Mb/s, S200-Mb/s, and S400-Mb/s data rates as specified in IEEE 1394-1995 and IEEE 1394a-2000.

~~A peak data rate of 400 Mb/s is required of all host controllers and PHY ports available externally in the system for 1999. The host controller must support 100-Mb/s, 200-Mb/s, and 400-Mb/s data rates as specified in IEEE 1394-1995 andIEEE P1394.a. All externally-accessible host controller ports must supportS100-400 operation.~~

[8.104] System provides IEEE 1394 System Boot Support

If the system hard disk drive or optical disk drive (CD or DVD) provided with the system is a 1394 device, the system BIOS firmware must support 1394 boot.

[8.24] If IEEE 1394 is implemented, system must use~~s~~ IEEE 1394 ~~1394b 2000~~ supported sockets

~~The PC must provide external interconnect to legacy nodes (for example, interconnect to 1394-1995 and/or 1394a-1999 devices).~~

~~**Note:** There must not be a mixture of IEEE 1394 sockets on the back panel of PC2 001 platform implementations.~~

~~The connector described in the *Device Bay Specification, Version1.0* (online at http://www.device-bay.org/) is for use inside the PC 2001 platform and is not, in general, considered to be an externally available socket.~~

A system that implements externally accessible sockets must provide a method for connecting to devices that only support IEEE 1394-1995 or its supplement, IEEE 1394a-2000.

The connector described in the *Device Bay Specification*, Version 1.0, available at http://www.device-bay.org, is for use inside the PC 2001 system and is not an externally available socket.

There must not be a mixture of IEEE 1394 socket types on the back panel.

~~**8.5 [DELETE] Design avoids excessive currents resulting form ground fault potential among devices**~~

Guidelines for IEEE 1394 Devices

This section summarizes additional requirements for IEEE 1394 peripherals.

[8.6] Device command protocols conform to standard device class interfaces

Drivers for devices using the SBP2 protocol must conform to the guidelines set in ~~the Windows 2000 DDK~~ "SBP-2 Support and Windows 2000."

The SBP-2 standard is available on the web at http://~~webstore.ansi.org~~www.microsoft.com/hwdev/print/sbp2_w2000.htm.

~~IEEE 1394 devices must comply with appropriate industry-recognized transport and command standards, such as the following:~~

~~? IEC 61883 parts 1-6, including CIP (Common Isochronous Packet) headers, CMP (Connection management Procedures), and FCP (Function Command Protocol)~~

~~? 1394TA AV/C 3.0 and the AV/C subunit family of specifications~~

~~? National Committee for Information Technology Standards (NCITS) SBP-2 transport protocols~~

~~? National Committee for Information Technology Standards (NCITS) T10, Reduced Block Commands (RBC)~~

~~? National Committee for Information Technology Standards (NCITS) T10 MMC-2, or SFF 8090, Version 3~~

~~Storage class devices must conform to the ANSI standards for SBP-2 (Serial Bus Protocol) with the appropriate command set: RBC (Reduced Block Commands) or MMC-2 (MultiMedia Commands).~~

~~Printing devices using the SBP2 protocol must conform to the guidelines set in "SBP-2 Support and Windows 2000," available at http://www.microsoft.com/hwdev/print/sbp2_w2000.htm~~

~~Drivers for IEEE 1394 must take advantage of WDM-based driver support provided in the operating system.~~

[8.7] Peak data rates for internal and external devices meet IEEE 1394 requirements~~IEEE 1394 devices support peak data rate of 400 Mb/s, minimum~~

System designers may incorporate IEEE 1394 devices as external, internal, or both. Minimum data rates may differ accordingly.

?? **[8.7.1] Internal IEEE 1394 devices support a peak data rate of S800-Mb/s, minimum.** Devices must support S800-Mb/s, minimum, as specified in the IEEE P1394b supplement standard.

Device Bay devices are an example of internal devices.

?? **[8.7.2] External devices support IEEE 1394a-2000 data transfer rates.** External devices that inter-operate with a PC and have more than one socket must support S100, S200, and S400 data transfer rates. ~~Pre-existing devices, such as those designed prior to the publication of these guidelines, and~~ Devices with a single socket may support only S100 or S200 data transfer rate.

Note to Reviewers: Please supply feedback on the 800 Mb/s minimum.

Plug and Play for IEEE 1394

This section summarizes the Plug and Play requirements for IEEE 1394 peripheral devices and PC host controllers.

[8.9] IEEE 1394 Plug and Play devices demonstrate interoperability with other devices

All devices must support Plug and Play for intended applications in both a minimal and an extended bus configuration. A minimal configuration is the minimum number of devices necessary to demonstrate the primary application of the device. An extended configuration is an advanced application with at least two devices added to the minimal configuration. The added devices can be extraneous to the application.

~~**8.10 [DELETE] Topology faults do not cause the bus to fail**~~

[8.11] [REDUNDANT] Removable media devices support media status notification

Note to Reviewers: See the related guidelines in the Storage chapter

[8.12] IEEE 1394 devices that initiate peer-to-peer communications provide a remote control interface

All devices capable of initiating peer-to-peer communications that have been designed for use with the PC must provide a remote interface (enabling remote control for PC applications) that allows a third device, such as a PC or some other device controller, to initiate data transmission between two devices.

For example, two devices communicating on IEEE 1394 use basic protocol to carry command/status information and the actual data (such as a device driver in the PC to handle this communication, and SBP-2 and 61883 as example protocols). Implementers must use their best engineering effort to implement an existing transport protocol before inventing a new communication protocol.

The IEC-61883 standard is available on the web at http://webstore.ansi.org.

Plug and Play for Configuration ROM

This section defines the Plug and Play requirements related to configuration ROM.

[8.13] IEEE 1394 Configuration ROM is provided for unique device identification

The device configuration ROM must provide configuration information as specified in the IEEE 1212r-2000 standard and applicable IEEE 1394 standards, thus providing Plug and Play device control.

[8.14] IEEE 1394 device configuration ROM implements general ROM format

The general configuration ROM format is specified in the applicable IEEE 1394 standards and the IEEE 1212r-2000 standard. The general ROM format is an extensible tree structure enabling a managed environment by providing node-specific and unit-specific information as required for Plug and Play, power management, and isochronous data transfers. The general ROM format also provides for definition of multifunction device units. The bus information block and root directory of the general ROM format are required as specified in configuration ROM table.

~~**8.15 [DELETE] Bus information block implemented at a base address offset of 0404h**~~

~~**8.16 [DELETE] Configuration ROM provides globally unique device ID**~~

~~**8.17 [DELETE] Root directory is located at a fixed address following the bus information block**~~

[8.18] IEEE 1394 configuration ROM includes a unit directory for each independent device function

A unit directory is required for independent function and control of each device unit. A valid pointer to a unit directory must be provided in the root directory. ~~at offset 0x20h, in compliance with the general ROM format specified in IEEE 1394-1995 and the directory format specified in ISO/IEC 13213:1994.~~

~~**8.19 [DELETE] Each unit directory provides a valid Unit_Spec_Id and Unit_Sw_Version**~~

~~**8.20 [DELETE] Each unit directory provides a pointer to a unit-dependent directory**~~

[8.21] Vendor and model leafs support textual descriptor leaf format

Textual descriptors are required for ~~Unit_Spec_ID and Unit_Sw_Version~~Vendor_ID and Model_ID entries in the configuration ROM in order to display this information to the user. Each textual descriptor points to a leaf that contains a single character string.

Examples of valid textual descriptors are found in the 1394 Plug and Play specification.

~~**8.22 [DELETE] Unit-dependent directory provides a pointer to the unit's CSRs**~~

[8.23] [REDUNDANT] ~~If IEEE 1394 is implemented, external connector ports are provided~~

Note to Reviewers: IEEE 1394 platform-specific guidelines have been moved into Part II of this guide.

[8.24] [MOVED] If IEEE 1394 is implemented, system must use~~s~~ IEEE ~~1394b 2000~~ supported sockets

Note to Reviewers: This item has been moved to "Guidelines for IEEE 1394 Devices"

~~**8.25 – 8.35 [DELETE]**~~

Power Management for IEEE 1394 Devices

All devices on the IEEE 1394 bus must comply with the power management requirements outlined in this section.

[8.36] Power Manager is notified of device power state changes

The host controller and all devices that provide or consume cable power must conform to all components of the *1394 Trade Association Power Specification*.

[8.37] Devices and controllers comply with all components of the 1394 Trade Association Power Specification

The Power Specification has been defined to provide guidelines for implementation of devices that propagate, source, or sink cable power. In addition, mechanisms are defined by which devices consuming cable power may be enabled as well as placed into a variety of power consuming states.

[8.38] [REDUNDANT] Devices and controllers comply with 1394 power specification

SCSI

This section presents guidelines for the small computer system interface (SCSI), a flexible I/O bus that is used in the design of a wide variety of peripherals, including disk drives, CD drives, tape drives, scanners, and magneto-optical drives. The SCSI host adapter is the circuitry that serves as an interface between the system and one or more SCSI peripherals. A host adapter can be a card that plugs into the system's expansion bus, such as a PCI card, or it can be designed directly into the system board.

SCSI Host Adapter Requirements

This subsection summarizes class specifications and standards for SCSI host adapters.

[NEW.8.102] SCSI controllers comply with SPI-3 standards

All SCSI controllers must meet the hardware and software design requirements listed in the SCSI Parallel Interface 3 (SPI-3) or later standard.

[11.1] SCSI host controller supports bus mastering and virtual DMA services

The host controller must support PCI bus mastering; PCI bus mastering must be enabled by default and virtual DMA services must be supported in the host-adapter option ROM.

Note to Reviewers: Redundant references to ROMs supporting Bus Mastering and Virtual DMA services are combined here. Other locations in the document will be deleted.

[11.2] Bootable SCSI controller supports El Torito No Emulation mode

SCSI host adapters with boot ROMs running in Intel Architecture platforms must support the current No Emulation mode of the *Bootable CD-ROM Format Specification, Version 1.0 (El Torito)*, or the *BIOS Boot Specification, Version 1.01*.

Note to Reviewers: This was changed for clarification.

[11.3] Option ROM supports Int 13h Extensions

Details are defined in requirement 3.5 in Chapter X, "PC 2001 Core System Guidelines"

[11.5] Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators

Connectors must comply with the requirements defined in the SCSI-2 or later standard. The SCSI bus cable must be plugged into shrouded and keyed connectors on the host adapter and devices. For internal configurations, Pin 1 orientation must be designated on one edge of the ribbon cable and also on the keyed connector of the SCSI peripheral device. For more information, see requirement 3.18, "Connections use icons, plus keyed or shrouded connectors, with color coding."

Although an external connector is optional, if an external connector is provided, it must be a high-density connector as defined in the SCSI-2 or later standard.

Connectors for each SCSI adapter, peripheral, cable, and terminator must be clearly labeled to indicate the bus type. All external SCSI connectors must display the appropriate SCSI icon defined in *Small Computer Interface Parallel Interface* (SPI) standard, Annex H, and must display any clarifying abbreviations or acronyms. The following are applicable acronyms and their definitions:

?? **DIFF (differential).** A signaling method that employs differential drivers and receivers to improve signal-to-noise ratios and increase maximum cable lengths. This method includes both low voltage differential (LVD) and high voltage differential (HVD) types.

?? **SE (single-ended).** A signaling method that employs drivers and receivers to increase circuit density.

?? **LVD (low voltage differential).** A signaling method similar to DIFF but with lower signaling voltages supporting higher transfer rates.

?? **HVD (high voltage differential).** A signaling method similar to DIFF but with higher signaling voltages.

[11.6] Differential Devices support DIFFSENS as defined in the SPI-3 Standard

Without DIFFSENS, the differential bus drivers, a single-ended device, or both could be damaged if a single-ended device is connected to a differential bus.

The standard for DIFFSENS is defined in ~~Section 5.4.2 of~~ the SPI-3 standards document.

[11.7] Automatic termination circuit and SCSI terminators meet ~~SCSI~~SPI-3 standard

SCSI add-on adapters and on-board controllers must use automatic termination, which allows a user to add external devices without removing the PC case. Terminators used in the SCSI host adapter must be regulated terminators, also known as active, ~~SCSI-3 SPI,~~ SCSI-2 alternative-2, or Boulay terminators. SCSI termination built onto internal cables must meet SCSI-3 standard.

[11.8] Terminator power is supplied to the SCSI bus with overcurrent protection

This requirement has two components:

?? **[11.8.1] Host adapter must supply terminator power.** The base requirement for system-board implementations using PCI or another expansion bus is that the host adapter must supply terminator power (TERMPWR) to the SCSI bus. All terminators on the host adapter, as well as those on the internal and external SCSI bus, must be powered from the TERMPWR lines on the SCSI bus.

?? **[11.8.2] The circuit that supplies TERMPWR must have built-in overcurrent protection.** Devices that provide TERMPWR must also provide some means of limiting the current through use of a self-resetting device. For example, a positive-temperature coefficient device or circuit breaker can be designed into the circuit. These devices open during an overcurrent condition and close after the end of the over-current condition.

Mobile PC Note

Although encouraged, this feature is not required for battery-powered systems that implement the SCSI host adapter as a PC Card device because of battery consumption issues.

Note to Reviewers: 11.9 and 11.11 were removed and consolidated in 11.5.
11.12 through 11.14 were moved to the Storage chapter to cover devices.
11.15 was removed due to application at a general host bus level. Also, since SCAM is not required, device application was no longer applicable.
11.17 was removed as redundant.
Other items moved to the Storage chapter to eliminate redundancy.

[11.10] Controller and peripherals implement SCSI bus data protection signal

The SCSI host adapter and all SCSI peripherals must implement the SCSI bus data protection signal defined in the SPI standard, and data protection must be enabled by default. This signal was formerly referred to as the parity signal.

Plug and Play for SCSI Host Adapters

This subsection summarizes the Plug and Play requirements for SCSI controllers.

[11.16] [REDUNDANT] Dynamic resource configuration is supported for all controllers

Note to Reviewers: This is a basic PC 2001 requirement that is no longer cited in every chapter

[11.18] SCAM support is disabled by default

If support is present, it must be disabled by default. SCAM is not supported by Windows operating systems; enabling SCAM can cause the system to become unstable or inoperable.

[11.20] SCSI controllers provide multi-initiator support

Multi-initiator support allows two SCSI controllers—each installed in a separate computer system—to coexist on a shared SCSI bus with a set of shared devices. If this capability is supported, the SCSI IDs must be changeable from the default SCSI controller ID of 7 and the boot-time SCSI bus reset operation must be able to be disabled on each controller attached to a shared bus.

~~This capability is recommended for hardware that will be used on systems using the clustering service available under Microsoft Windows 2000 Advanced Server. To use this service, a SCSI adapter and a SCSI peripheral must provide multi-initiator support for at least two initiators.~~

ATA and ATAPI

This section presents the requirements for Windows-compatible ATA (AT Attachment), ATAPI (ATA Packet Interface) controllers and peripherals. ATA—also known as IDE (Integrated Device Electronics)—is one of the most widely used interfaces in the PC world.

The use of ATA in a PC 2001 system is optional. If ATA is used, however, all components must comply with the requirements defined in this chapter.

[10.1] IDE controllers comply with ATA/ATAPI-~~4~~ 5 standards

All ATA/ATAPI controllers must meet the hardware and software design requirements listed in the ATA/ATAPI-~~4~~ 5 or later standard.

~~**Note:** External storage subsystems that require advanced features such as command queuing should use IEEE 1394 for the storage interface. Internal primary storage that requires these advanced features should use SCSI.~~

[10.2] Bootable ATA controller supports El Torito No Emulation mode

Details are defined in requirement 3.5 in Chapter X, “PC 2001 Core System Guidelines”

10.3 [REDUNDANT] Option ROMs support Int 13h Extensions

Note to Reviewers: This basic PC 2001 requirement is defined in 3.5

[10.4] If implemented, dual ATA adapters use single FIFO with asynchronous access or dual FIFOs and channels

Although the use of an ATA adapter with more than one channel is optional, if included, dual ATA adapters must be designed so that either channel might be used at any time; the operating system does not have to serialize access between the primary and secondary channel. This requirement means either that the two channels are totally independent or that anything shared, such as a programmed I/O (PIO) read pre-fetch buffer, is protected by a hardware arbitrator.

Section 5.0 of the *Compaq, Intel, and Phoenix BIOS Boot Specification* defines an implementation for dual asynchronous channels. This specification is available at http://www.ptltd.com/techs/specs.html.

A design implementing a single first in/first out (FIFO) that uses a hardware solution to synchronize access to both channels meets this requirement. A request on one channel need not be completed before another request to the other channel can be started. A software-based solution is not acceptable.

Note to Reviewers: 10.5 requirement was combined with section 10.3 above.

[10.6] [REDUNDANT] System BIOS supports ARMD

Note to Reviewers: This guideline is defined in requirement 3.5.

[10.7] Controller supports Ultra DMA (ATA/33 or higher)

The programming register set for PCI IDE bus master direct memory access (DMA) is defined in ATA-5. ATA drives must comply with ATA--5 to ensure fully featured hardware and Windows-compatible device driver support.

All controllers and ATA hard drive peripherals must support Ultra DMA at transfer rates of 33 MB per second or higher as defined in ATA/ATAPI-5. In addition to improved transfer rates, Ultra DMA also provides error checking for improved robustness over previous ATA implementations. PCI chip sets must implement DMA as defined in ATA-5.

The system BIOS must configure the drive and host controller~~,~~ optimized for Ultra DMA operation. Programmed I/O (PIO) mode must continue to work. The ~~ACPI software should~~ IDE device driver must also support restoration of these settings using the ACPI control methods _GTM, _STM, and _GTF when the ATA controller is power managed across a suspend and resume cycle. ~~The BIOS pre-operating system boot disk services, (INT13h read and write) need not actually use Ultra DMA for access of the drive prior to operating system boot.~~

Definitions for the above ACPI control methods can be found in Section 10.8 of the *Advanced Configuration and Power Interface Specification, Revision 1.0b* or later~~, with consideration of the ACPI errata available on the web site at http://www.teleport.com/~acpi/tech.htm~~.

[10.8] Controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors

Pin 1 orientation must be designated by one edge of the keyed ribbon cable and also on the keyed connector of the ATA or ATAPI controller and peripheral device. Designation of the keyed connector must be clearly indicated on or near the connector.

[10.11] BIOS enumeration of all ATAPI devices complies with ATA/ATAPI-5

The ATA/ATAPI-5 standard defines the enumeration process for all ATAPI devices.

Note to Reviewers: 10.11 will move to the system BIOS requirements item 3.5 in the next draft; 10.9, 10.10 and 10.12 have been moved to the storage chapters.

[10.13] [REDUNDANT] Each controller has a Plug and Play device ID

Note to Reviewers: This basic PC 2001 requirement is no longer defined in each chapter.

[10.14] [REDUNDANT] Dynamic resource configuration is supported for all controllers

[10.15] [REDUNDANT] Resource configuration meets bus requirements

Note to Reviewers: Other items removed as out-of-date.

[10.17] ATA Channel complies with device class power management reference specification

The ATA channel must comply with the *Storage Device Class Power Management Reference Specification, Version 1.0a* or later.

Note to Reviewers: 10.18 was moved to the storage chapter.

PCI

This section presents the PC 2001 guidelines for Peripheral Component Interconnect (PCI) host controllers and peripherals.

The PCI architecture has become the most common method used to extend PCs for add-on adapters. Windows 98 and Windows 2000 use the basic PCI infrastructure to gain information about devices attached to the PCI bus. The

ability of PCI to supply such information makes it an integral part of the Plug and Play architecture in Windows.

PCI Basic Guidelines

This section summarizes the basic design guidelines for PCI.

[9.1] All PCI components comply with PCI 2.2

All cards, bridges, and devices that use PCI must be designed to meet the requirements defined in *PCI Local Bus Specification, Revision 2.2* (PCI 2.2). ~~Compliance with this requirement is demonstrated based on the compliance process of the PCI SIG.~~

[9.3] PCI-to-PCI bridges comply with the *PCI to PCI Bridge Specification, Revision 1.1*

In particular, non-subtractive decode PCI bridges must implement the standard method to close BAR windows. Setting the base address register (BAR) to its maximum value and the limit register to zeros effectively closes the I/O or memory window references in that bridge BAR.

[9.4] System provides 3.3 V to all PCI connectors

PC 2001 systems are required to provide 3.3 volts with amperage as defined by PCI 2.2 to all PCI connectors. This requirement enables the development of 3.3 V PCI adapters without the cost of voltage regulators.

[9.5] PCI add-on devices support 3.3 V signaling

PCI add-on devices can be implemented as Universal Boards as defined in Section 4.1 of the PCI 2.2 specification, or be as 3.3 V devices that are “5 V tolerant.” These devices support both 3.3 V and 5 V signaling.

PCI Controller Guidelines

This section summarizes PCI controller requirements.

[9.6] System-board bus complies with PCI 2.2

The system-board bus hardware must comply with PCI 2.2. The bus design must fully implement all bus requirements on every expansion card connector.

[9.9] All PCI devices complete memory write transaction (as a target) within specified times

All devices must comply with the Maximum Completion Time requirements that are documented in PCI 2.2. Complying with this requirement ensures shorter transaction latencies on PCI, allowing more robust handling of isochronous streams in the system.

Plug and Play for PCI Controllers and Peripherals

This section summarizes the Plug and Play requirements for PCI devices.

[9.11] PCI Device IDs include Subsystem IDs

The Subsystem ID (SID) and Subsystem Vendor ID (SVID) fields must comply with the Subsystem ID requirement in PCI 2.2. See the white paper "PCI Device Subsystem IDs for Windows," available at http://www.microsoft.com/hwdev/devdes/pciids.htm.

?? The PCI SIG assigns valid, non-zero Vendor ID values to member companies. This Vendor ID value must be used to populate the SVID register.

?? The vendor assigns values for the SID register. To be valid, these values must be non-zero and unique to a subsystem configuration.

Note to Reviewers: The following material in guideline 9.11 was published in PC99A and presented again here to ensure review and to gather industry input on this section. This material will not be included in the final draft.

Valid non-zero values in the SVID and SID registers are necessary for the correct enumeration of the PCI device. When these registers are populated correctly for a PCI subsystem or add-on board, the operating system can differentiate between subsystems and add-on boards based on the same PCI chip.

The PCI specification and these guidelines require that the SVID and SID registers are loaded with valid non-zero values before the operating system accesses the Configuration Space registers on a PCI device or function. This action is required both at initial operating system load and after any transition of the PCI bus from B3 (the unpowered bus state) back to B0 (the fully powered bus state).

For add-on boards, this requirement must be done by hardware on the board itself—for example, by way of serial EEPROM—and not by an extension BIOS or device driver. This action is required because the extension BIOS code or driver code is not guaranteed to run in all relevant cases, especially for system sleep transitions or dynamic bus power state transitions in which the bus becomes unpowered. Hardware methods to support this include:

?? Pin strapping at Reset

?? Loading from an attached parallel or serial ROM

For subsystems on system boards that contain a PCI device, the SVID and SID registers must also be loaded with valid non-zero values before the operating system accesses the device. The exceptions to this requirement are PCI-to-PCI bridges and core chip sets.

For subsystems on system boards that contain a PCI device, the SVID and SID registers must also be loaded with valid non-zero values before the operating system accesses the device. The subsystem exceptions to this requirement are certain sub-classes of bridges and core chipset components, which are specified in section 6.2.4 and Appendix D of the *PCI 2.2 Local Bus Specification*. The PCI 2.2 specification became the industry standard on December 18, 1998. For the convenience of the reader, the excepted sub-classes of bridges (PCI base class 6) and core chip set components (PCI base class 8) are listed here, but for full information the reader must refer to the PCI 2.2 specification:

?? Bridges (PCI base class 6)
    ?? Host bridge (Sub-class 0)
    ?? Host bridge (Sub-class 0)
    ?? ISA bridge (Sub-class 1)
    ?? EISA bridge (Sub-class 2)
    ?? MCA bridge (Sub-class 3)
    ?? PCI-to-PCI bridge and Subtractive Decode PCI-to-PCI bridge (Sub-class 4)
?? Core chip set components (PCI base class 8)
    ?? Generic 8259, ISA, EISA, and I/O APIC programmable interrupt controllers (Sub-class 0)
    ?? Generic 8237, ISA, and EISA DMA controllers (Sub-class 1)
    ?? Generic 8254, ISA, and EISA system timers (Sub-class 2)
    ?? Generic and ISA RTC controllers (Sub-class 3)

Audio/modem riser (AMR) devices and modem riser (MR) devices on the motherboard are not exempt from the requirement for SID and SVID.

The system BIOS power-on self test (POST) code or ACPI control methods (_PS0 for PCI bus B3 to B0 transitions) are guaranteed to run before the operating system accesses the SVID or SID registers. Once the operating system has control of the system, the SVID and SID registers must not be directly writable—that is, the read-only bit must be set and valid. See the note on using the POST method for loading SVID and SID register values related to multiple-monitor support for display devices in requirement [14.45], “Each device has a Plug and Play device ID.”

[9.13] PCI interrupt routing is supported using ACPI

The system must provide interrupt routing information using a _PRT object, as defined in Section 6.2.3 of the ACPI 1.0b specification.

[9.14] BIOS does not configure I/O systems to share PCI interrupts

This applies to boot devices configured by the BIOS on systems based on Intel Architecture processors. The operating system must configure all other devices. For systems that will run the Microsoft Windows family of operating systems, OEMs must design the BIOS so that it does not configure the I/O systems in the PC to share PCI interrupts for boot devices.

~~An exception exists for legacy audio devices following the configuration guidelines outlined in *Implementing Legacy Audio Devices on the PCI Bus*, available at http://www.intel.com/pc-supp/platform/ac97/wp/leg_pci.htm.~~

Windows does not support sharing an IRQ between real-mode and protected-mode code within the I/O subsystem. For example, when an NDIS 2.0 driver (real mode) and a SCSI miniport driver (protected mode) for two PCI devices share the same IRQ, the IRQ needs to be reflected to real mode for the NDIS 2.0 driver to work.

However, if the IRQ is reflected to real mode, the real-mode SCSI driver, which usually is not called because Windows takes over in protected mode, might touch the hardware, causing the SCSI miniport to be confused. Windows resolves this problem either by switching everything to protected mode or by falling back to real mode.

[9.15] BIOS configures boot device IRQ and writes to the interrupt line register

This requirement applies to boot devices configured by the BIOS on systems based on Intel Architecture processors. Windows should configure all other devices because, after an IRQ is assigned by the system BIOS, Windows cannot change the IRQ. If the BIOS assigns the IRQ and Windows needs it for another device, a sharing problem occurs.

The BIOS must configure the boot device IRQ to a PCI-based IRQ and must write the IRQ into the interrupt line register 3Ch, even if the BIOS does not enable the device. This way, the operating system can still enable the device with the known IRQ at configuration time, if possible.

[9.16] System that supports hot plugging for any PCI device uses ACPI-based methods

Hot-plugging capabilities are not required for PCI devices. Windows 98 and Windows 2000 support dynamic enumeration, installation, and removal of PCI devices only if there is a supported hardware insert/remove notification mechanism.

The appropriate notification mechanism is supported as a bus standard for CardBus bus controllers. For other solutions, such as those required for docking stations or hot-plugging PCI devices, the hardware insert/remove notification

mechanism must be implemented as defined in Section 5.6.3 of the ACPI 1.0ba specification (or later).

[NEW.8.103] System that supports PCI-X complies with PCI-X 1.0

All cards, bridges, and devices that use PCI-X must be designed to meet the requirements defined in *PCI-X Specification, Revision 1.0* (PCI-X 1.0). ~~Four-slot, 660 MHz desktop PC are expected in the marketplace by mid-2001.~~

Power Management for PCI Controllers and Peripherals

This section summarizes the specific PCI power management requirements.

[9.17] All PCI components comply with PCI Bus Power Management Interface specification

PCI Bus Power Management Interface Specification, Revision 1.1 or later, is the only industry specification that ensures compatibility with the power management capabilities of Windows 2000, which uses PME# as the wake-up signal.

The primary PCI bus controller, PCI-to-PCI bridges, and all add-on capable devices on the PCI bus must comply with the *PCI Bus Power Management Interface Specification, Revision 1.1* or later~~, whether or not the system they are installed in provides 3.3Vaux to its PCI connectors~~.

?? **[9.17.1] All components correctly implement configuration space registers used for power management.** This PC 2001 requirement includes correct implementation of the PCI Configuration Space registers used by power management operations, and the appropriate device state (Dx) definitions.

Functions (for example, PCI-to-PCI bridges, USB host controllers, IDE controllers, and so on) that are integrated as part of the core chipset, and thus not add-on capable devices, can use ACPI (and not PCI Power Management registers) for their power management interface.

?? **[9.17.2] After-market PCI add-on cards using 3.3Vaux must operate correctly.** PCI add-on cards that use 3.3Vaux must operate correctly, regardless if the system supports 3.3Vaux to the PCI connectors.

PC add-on cards designed and built exclusively for installation in OEM systems—and which are never sold through retail distribution channels—are not required to supply the static FET switches described in section 7.4.4 of the *PCI Bus Power Management Specification*.

On OEM systems that supply 3.3Vaux, the OEM-version PCI add-on card's split Vaux power plane is tied directly to the 3.3Vaux pin on the system PCI connector. For systems that do not deliver 3.3Vaux, the OEM-version PCI add-on card's Vaux power plane is tied directly to the required 3.3VPCI source.

A method that PCI add-on cards can use to meet this requirement is described in Section 7.4.4 of the *PCI Bus Power Management Interface Specification*: Static FET switches on the add-on card re-route 3.3VPCI, or converted 5VPCI, to the 3.3Vaux power plane when the card is installed in a system that does not supply 3.3Vaux. ~~However, the added cost of these static FET switches is not justified for PCI add-on cards installed exclusively in OEM systems.~~

[9.18] System provide s support for 3.3 Vaux ~~if a system supports S3 or S4 states~~

System support for delivery of 3.3 Vaux to the PCI bus must be capable of powering a single PCI slot with 375 mA at 3.3 V and it must also be capable of powering each of the other PCI slots on the segment with 20 mA at 3.3 V whenever the PCI bus is in the B3 state.

Note to Reviewers: Mobile vendors—provide feedback on whether this requirement is too high for Mobile systems.

Systems must be capable of delivering 375 mA at 3.3 V to all PCI slots whenever the PCI bus is in any "bus powered" state: B0, B1, or B2.

[9.19] PCI bus power states are correctly implemented

Note to Reviewers: This is redundant because it is in the ACPI specification. Our goal is to not reproduce spec data in these guidelines.

~~The PCI bus must be in a bus state (B*x*) no higher than the system sleeping state (S*x*). This means that if the system enters S1, the bus must be in B1, B2, or B3. If the system enters S2, the bus must be in B2 or B3, and if the system enters S3, the bus must be in B3. Of course, in S4 and S5, the system power is removed, so the bus state is B3. A PCI bus segment must not transition to the B3 state until all downstream devices have transitioned to D3.~~

Control of a PCI bus segment's power is managed using the originating bus bridge for that PCI bus segment.

?? For CPU-to-PCI bridges, these controls must be implemented using ACPI or the PCI Power Management Interface Specification, Revision 1.1 or later.

?? For PCI-to-PCI bridges, these controls must be implemented in compliance with the PCI Power Management Interface Specification, Revision 1.1 or later.

[9.20] PCI-based modem and network adapters support wake-up

PCI-based modem and network adapters must support wake-up as follows:

?? Modem adapters must be capable of generating a power management event (PME# assertion) from the D3 cold device state.

?? Network adapters must support the generation of a power management event (PME# assertion) from the D3 cold device state if the physical layer technology is generally capable of operating under the voltage and current constraints of the D3 cold device state. Network adapters must also support the minimum requirements for network packet filtering/wake-up capability as defined in the requirement 20.56, “Device supports wake-up events.”

Mobile PC PCI Issues

The following guideline describes a PCI issue on a Mobile PC.

[6.26] System supports PCI docking through a bridge connector

See complete details in Chapter X, “Mobile PC 2001.”

[13.8] [REDUNDANT] All devices meet PC 2001 general device requirements

Note to Reviewers: This is a basic PC 2001 requirement that is not repeated in every chapter

Checklist for Buses and Interfaces

[7.1] USB controllers and devices comply with USB specifications

[7.2] Systems include BIOS support for USB keyboards and hubs

[7.3] All USB system hardware, hubs, and devices comply with USB 1.1 specification

[7.4] [REDUNDANT] Connections use USB icon

[7.5] USB devices and drivers support maximum flexibility of hardware interface options

[7.6] USB host controller meetsOpenHCI or UHCI specification

[7.7] USB host controller can wake the system

[7.8] [REDUNDANT] USB hubs comply with USB 1.1 or specifications

[7.9] All hubs must be self-powered except hubs integrated into USB keyboards

[7.10] Systems and USB devices comply with USB power management requirements

[7.11] USB devices meet requirements in related USB device class specification

[NEW.8.101] USB devices install without pre-loading software or drivers and without rebooting the system

[6.5] Mobile PC includes at least one USB port

[6.6] For mobile PC, USB-connected internal device does not maintain fully on power state

[8.1] Systems implementing IEEE 1394 support mandatory features in IEEE 1394 standards

[8.2] Host controllers support mandatory components of 1394 OpenHCI 1.1

[8.3] [REDUNDANT] OpenHCI controllers and devices support advances defined in IEEE 1394a

[8.4] Host controller supports minimum peak data rates, as specified in the applicable IEEE 1394 standards

[8.104] System provides IEEE 1394 System Boot Support

[8.24] If IEEE 1394 is implemented, system must use IEEE 1394 supported sockets

[8.6] Device command protocols conform to standard device class interfaces

[8.7] Peak data rates for internal and external devices meet IEEE 1394 requirements

[8.9] IEEE 1394 Plug and Play devices demonstrate interoperability with other devices

[8.11] [REDUNDANT] Removable media devices support media status notification

[8.12] IEEE 1394 devices that initiate peer-to-peer communications provide a remote control interface

[8.13] IEEE 1394 Configuration ROM is provided for unique device identification

[8.14] IEEE 1394 device configuration ROM implements general ROM format

[8.18] IEEE 1394 configuration ROM includes a unit directory for each independent device function

[8.21] Vendor and model leafs support textual descriptor leaf format

[8.23] [REDUNDANT]

[8.24] [MOVED] If IEEE 1394 is implemented, system must use IEEE supported sockets

[8.36] Power Manager is notified of device power state changes

[8.37] Devices and controllers comply with all components of the 1394 Trade Association Power Specification

[8.38] [REDUNDANT] Devices and controllers comply with 1394 power specification

[NEW.8.102] SCSI controllers comply with SPI-3 standards

[11.1] SCSI host controller supports bus mastering and virtual DMA services

[11.2] Bootable SCSI controller supports El Torito No Emulation mode

[11.3] Option ROM supports Int 13h Extensions

[11.5] Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators

[11.6] Differential Devices support DIFFSENS as defined in the SPI-3 Standard

[11.7] Automatic termination circuit and SCSI terminators meet SPI-3 standard

[11.8] Terminator power is supplied to the SCSI bus with overcurrent protection

[11.10] Controller and peripherals implement SCSI bus data protection signal

[11.16] [REDUNDANT] Dynamic resource configuration is supported for all controllers

[11.18] SCAM support is disabled by default

[11.20] SCSI controllers provide multi-initiator support

[10.1] IDE controllers comply with ATA/ATAPI-5 standards

[10.2] Bootable ATA controller supports El Torito No Emulation mode

10.3 [REDUNDANT] Option ROMs support Int 13h Extensions

[10.4] If implemented, dual ATA adapters use single FIFO with asynchronous access or dual FIFOs and channels

[10.6] [REDUNDANT] System BIOS supports ARMD

[10.7] Controller supports Ultra DMA (ATA/33 or higher)

[10.8] Controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors

[10.11] BIOS enumeration of all ATAPI devices complies with ATA/ATAPI-5

[10.13] [REDUNDANT] Each controller has a Plug and Play device ID

[10.14] [REDUNDANT] Dynamic resource configuration is supported for all controllers

[10.15] [REDUNDANT] Resource configuration meets bus requirements

[10.17] ATA Channel complies with device class power management reference specification

[9.1] All PCI components comply with PCI 2.2

[9.3] PCI-to-PCI bridges comply with the PCI to PCI Bridge Specification, Revision 1.1

[9.4] System provides 3.3 V to all PCI connectors

[9.5] PCI add-on devices support 3.3 V signaling

[9.6] System-board bus complies with PCI 2.2

[9.9] All PCI devices complete memory write transaction (as a target) within specified times

[9.11] PCI Device IDs include Subsystem IDs

[9.13] PCI interrupt routing is supported using ACPI

[9.14] BIOS does not configure I/O systems to share PCI interrupts

[9.15] BIOS configures boot device IRQ and writes to the interrupt line register

[9.16] System that supports hot plugging for any PCI device uses ACPI-based methods

[NEW.8.103] System that supports PCI-X complies with PCI-X 1.0

[9.17] All PCI components comply with PCI Bus Power Management Interface specification

[9.18] System provides support for 3.3 Vaux

[9.19] PCI bus power states are correctly implemented

[9.20] PCI-based modem and network adapters support wake-up

[6.26] System supports PCI docking through a bridge connector

[13.8] [REDUNDANT] All devices meet PC 2001 general device requirements

CHAPTER 9

Input Devices

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 11:51 AM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter presents requirements for input devices, including ~~serial and parallel~~legacy ports, wireless capabilities, and input devices and connectors.

~~System designers are encouraged to consider solutions such as USB rather than traditional connections for external devices.~~USB support is required for PC 2001 systems, and easy connectivity is important in situations where devices might be interchanged on a regular basis. USB replaces legacy serial and parallel ports as the dominant external connector.

General Input Device Requirements

This section summarizes requirements for ~~serial and parallel~~legacy ports.

[NEW.13.101] All non-integrated input devices meet USB HID specifications

Note to Reviewers: This new requirement is similar to PC 99 [5.3].

All keyboards, pointing devices, game pads, and their connections included with a PC 2001 system must comply with the *USB Device Class Definition for Human Interface Devices, Version 1.1* or later, and *USB HID Usages Table, Version 1.1 or later*. This is required whether the devices are implemented as wired or wireless.

For implementation guidelines under the Windows family of operating systems, see the Windows 2000 DDK. See also the web site available at http://www.microsoft.com/hwdev/input/.

Note to Reviewers: This is a key requirement for legacy migration advances for PC 2001.

~~**[13.1] [DELETE] System includes connection for external serial devices**~~

~~**[13.2] [DELETE] System includes connection for external parallel devices**~~

~~**[13.3] [DELETE] System includes external connection for keyboard**~~

~~**[13.4] [DELETE] System includes pointing device connection and pointing device**~~

~~**[13.5] [DELETE] System includes USB game pad or joystick**~~

~~**[13.6] [DELETE] System includes built-in wireless capabilities**~~

[13.7] Devices use USB or external bus connections rather than legacy serial or parallel ports

Although legacy parallel and serial ports can be provided on a PC 2001 system, no devices that use these ports can be provided with a system~~, with the exception of printers~~. A legacy serial port cannot be used as the connection for the mouse or modem.

[13.8] [REDUNDANT] All devices meet PC 2001 general device requirements

Note to Reviewers: This is a general PC 2001 requirement and is not repeated for every device class

[13.9] Serial port meets device class specifications for its bus

Note to Reviewers: In future versions of this design guide, this section will address mappers for USB and legacy ports.
Please comment about how you believe the design guide should address mappers.

As required for all PC 2001 devices, a serial port implementation that uses a non-legacy bus must meet the specific device class requirements for that bus.

For example, a USB serial port implementation must comply with all related USB specifications, including:

?? *Universal Serial Bus Specification, Version ~~1.0~~1.1* or later (also known as the USB core specification)

?? *Universal Serial Bus Device Class Definition for Communication Devices, Version 1.0* or later

The "Standard Serial Interface Circuit Emulation" appendix in the *USB Device Class Definition for Communication Devices* specifically addresses serial-port compatibility.

[13.10] If implemented, legacy serial port is implemented as 16550A UART or equivalent and supports 115.2K baud

Legacy ports are discouraged for PC 2001 systems, but if implemented, such ports must meet the requirements defined in *Legacy Plug and Play Guidelines*, available online at http://www.pcdesguide.org/library.htm.

[13.11] If implemented, legacy serial port supports dynamic resource configuration

For implementation guidelines, see *Legacy Plug and Play Guidelines*, available online at http://www.pcdesguide.org/library.htm.

[13.12] If legacy serial port is implemented, conflict resolution ensures availability of at least one serial port

For implementation guidelines, see *Legacy Plug and Play Guidelines.*

[13.13] Parallel port meets device class specifications for its bus

Note to Reviewers: In future versions of this design guide, this section will address mappers for USB and legacy ports.
Please comment about how you believe the design guide should address mappers.

As required for all PC 2001 devices, a parallel port implementation that uses a non-legacy bus must meet the specific device class requirements for that bus.

For example, a parallel port implementation that uses USB must comply with all related USB specifications, including the USB core specification and any specific device class specification.

[13.14] If a legacy parallel port is implemented, flexible resource configuration is supported for each parallel port

For implementation guidelines, see *Legacy Plug and Play Guidelines.*

[13.15] If a legacy parallel port is implemented, EPP support does not use restricted I/O addresses

For implementation guidelines, see *Legacy Plug and Play Guidelines.*

[13.16] If a legacy parallel port is implemented, compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications

For implementation guidelines, see *Legacy Plug and Play Guidelines.*

[13.17] If a legacy parallel port is implemented, port connectors meet IEEE 1284-I specifications, minimum

For implementation guidelines, see *Legacy Plug and Play Guidelines.*

[13.18] If a legacy parallel port is implemented, IEEE 1284 peripherals have Plug and Play device IDs

For implementation guidelines, see *Legacy Plug and Play Guidelines.*

~~**[13.19] [DELETE] Device identification string provides a Compatible ID key**~~

Note to Reviewers: Recommendations are not included in PC 2001.

[13.20] If implemented, daisy-chained parallel port device is Plug and Play capable

Daisy-chained parallel port devices must be Plug and Play capable. The daisy-chained parallel port device must be capable of answering Plug and Play requests from the host.

All pass-through devices must comply with IEEE 1284.3 because of end-of-chain issues with IEEE 1284 and IEEE 1284.3.

[13.21] Pointing-device connection meets requirements for its bus class

If a USB port is used, the following requirements must be met:

?? Meet requirements in *USB Specification, Version 1.1* or later

?? Meet requirements in *USB Human Interface Device Class Specifications, Version 1.1* or later

?? Implement minidriver support based on WDM Human Interface Device (HID) class support in the operating system, as defined in the Windows 2000 DDK

For information about implementing minidriver support based on WDM Human Interface Device (HID) class support in the operating system, see “Chapter 1 I/O Requests for HID Minidrivers” in the Windows 2000 DDK, which defines the implementation for both Windows 98 and Windows 2000 (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/hidioreq_92k2.htm).

For implementation guidelines for legacy devices, see *Legacy Plug and Play Guidelines*.

~~**13.22. [DELETE] Remote control pointing device provides PC 2001 minimum support**~~

Note to Reviewers: Recommendations are not included in PC 2001.

[13.23] Keyboard connection meets requirements for its bus class

If a USB connection is used, it must meet the following requirements:

?? *USB Specification, Version 1.1* or later

?? *USB Human Interface Device Class Specifications, Version 1.1* or later

?? Minidriver support based on WDM HID class support in the operating system

If a USB keyboard is the sole keyboard implementation in an Intel Architecture system, it must support the USB Boot Device specification. The system BIOS must provide boot support as specified in requirement [3.5], "BIOS meets PC 2001 requirements for boot support," and as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or later.

For implementation guidelines for legacy devices, see *Legacy Plug and Play Guidelines*.

[13.24] No interference occurs between multiple keyboards

Mobile PC Note

If the system includes more than one keyboard, there must be no conflicts. For example, when a mobile PC is connected to a docking station, more than one keyboard can be attached to the system simultaneously. The keyboard ports on a mobile PC and a docking station must be able to resolve conflicts between the two ports when the mobile unit is docked. Windows supports multiple configurations through the registry and will determine which keyboard to enable.

For more information about managing resources and devices for a mobile PC/docking station pair, see Chapter [X], "Mobile PC 2001."

[13.25] If implemented, Windows and Application logo keys meet Microsoft guidelines

The following are requirements for a keyboard design that includes any Windows logo keys:

?? The keyboard must be developed according to technical requirements in *New Key Support for Microsoft Windows Operating Systems and Applications*.

The keyboard scan codes for Windows operating systems are available at http://www.microsoft.com/hwdev/desinit/scancode.htm.

?? The keyboard must be compatible at the Windows virtual key-code level.

?? The keyboard must pass the requirements in the Windows logo key testing software.

?? The Windows logo key must function as a modifier (CTRL, SHIFT, or ALT).

?? The Windows Flag trademark must be clearly distinguished on the key top according to the guidelines provided in *New Key Support for Microsoft Windows Operating Systems and Applications*.

Mobile PC Note

~~Given the crowded nature of compact keyboards on mobile PCs and keyboards that support double-byte characters, such as Japanese-language keyboards, it might be difficult to add three new keys.~~ For mobile PCs, minimal implementation of new keys includes the addition of one Windows logo key and one Application key.

13.26. [REDUNDANT] Game-control device meets USB HID class specification requirements

Note to Reviewers: Legacy and proprietary game-pad solutions are not acceptable for PC 2001. Game pads, joysticks, and other input devices must be implemented as USB devices.

Wireless Component Requirements

Note to Reviewers: This section is still being reviewed for modern RF implementations. Your input is requested. Compare similar guidelines in the Communications chapter under "Home Networking Guidelines."

This section defines requirements for wireless components, provided either as infrared (IR) and radio frequency (RF) devices, based on communication standards developed by the Infrared Data Association (IrDA).

For information about requirements for wireless networking devices, see "IrDA Requirements for Network Communications" in Chapter [X], "Communication Devices."

The requirements listed in this section must be met if wireless capabilities are provided in the system. The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

Manufacturers who are implementing designs that include IrDA Control devices, also known as IrBus, are strongly encouraged to join IrDA and to obtain the IrDA-approved version of the IrDA Control specification, plus information on the availability of parts and driver software.

[13.27] IR device uses NDIS 5.0 miniport driver

This requirement applies for IrDA Data devices. An NDIS 5.0, IrDA miniport driver is required for all IrDA Data devices. For documentation and sample source code for building a miniport driver, see ~~the Windows 2000 DDK.~~

~~For documentation and sample source code for building a miniport driver,~~"Chapter 10 IrDA Miniport NIC Drivers" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2k/210irda_8fdz.htm).

[13.28] IR device meets IrDA specifications

~~upport specifications for both IrDA Data and IrDA Control devices.~~

An IR device must be designed to comply with approved IrDA specifications.

If the system is intended to run data transfer applications with other IrDA Data devices, it must be in compliance with the IrDA Data specification.

If an IrDA Control application is used in a PC 2001 system, it must be in compliance with the IrDA Control specification, which was approved by IrDA in early 1998. The first IrDA Control-compliant devices are expected to ship in late 1998.

~~If a system is intended for the consumer market, it should have support for both IrDA Control and IrDA Data is recommended to meet the consumer's expectations for IR device interoperability. The emergence of still image cameras with IrDA Data capability increases the importance of IrDA Data support in consumer systems.~~

[13.29] [REDUNDANT]IR device meets PC 2001 bus and port specifications

Note to Reviewers: This is a basic PC 2001 requirement.

[13.30.] [REDUNDANT] IR device supports dynamic resource configuration

Note to Reviewers: This is a basic PC 2001 requirement.

[13.31.] [REDUNDANT] IR device meets USB guidelines for interfacing with IrDA Data and IrDA Control devices

[13.32] System supports standard input speeds of 4 Mb/s

Device support is required for Fast IR (FIR) input speeds of 4 Mb/s for all IrDA Data devices.

[13.33] System provides a separate, physically-isolated transceiver for each IR protocol supported

This requirement ensures correct implementation for a system that includes IR support for any combination of devices that use the IrDA Data protocol, the IrDA Control protocol, or the universal consumer-IR approach to legacy remote control, each of which use different device signals. ~~A system that uses only a specific IR device protocol will restrict the ability to use multiple input devices and might also restrict other capabilities.~~

~~A PC 2001 system that advertises itself as supporting all three IR solutions — IrDA Data protocol, IrDA Control protocol, and legacy remote control IR — must~~

~~provide a separate transceiver for each solution.~~ The system must also expose each separate transceiver to the operating system.

~~The transceivers must be physically isolated from each other; an example is placing each transceiver on a different edge of the system case. Although some IrDA member companies have tested IrDA Data, IrDA Control, and legacy remote control IR transceivers without spatial separation and demonstrated adequate performance, interference-free operation cannot be assured without physical isolation.~~

If multiple IR protocols are supported, controllers must provide separate data connections into the PC using USB. The IrDA and USB industry associations define guidelines for how to build and interface such devices. Contact information can be found in "References for Input Devices" later in this chapter.

~~13.34. [DELETE] System supports RF capabilities~~

Note to Reviewers: Recommendations are not included in PC 2001

~~13.35. [DELETE] RF implementation uses a low-power RF alternative~~

Note to Reviewers: Recommendations are not included in PC 2001

~~13.36. [DELETE] RF implementation provides a method to defeat noise and conflict with other RF devices~~

Note to Reviewers: Recommendations are not included in PC 2001

~~13.37. [DELETE] System and RF device have separate local certification~~

Note to Reviewers: Recommendations are not included in PC 2001

Mobile PC Wireless Design

This section defines requirements for wireless devices used with a mobile PC.

[6.10] If implemented in a mobile PC, IR devices support power management ~~Mobile PC includes IR devices compliant with IrDA specifications~~

IR capabilities are not required for mobile PCs. If implemented, all devices must meet the PC 2001 requirements for IrDA devices as defined in the "Wireless Component Requirements" section of this chapter See also "Wireless Design Issues" in Chapter X, "PC 2001 Design Issues."

IrDA devices must support D0 and D3 states, controlled by methods defined in Section 3.4 of the ACPI 1.0b specification, or by the relevant bus-specific methods. ~~In addition, the software must have access to turning the interface off (D3 power state) and on (D0 power state) using bus-specific methods or the methods defined in Section 3.4 of the ACPI specification.~~

Smart Card Requirements

This section defines requirements for smart card devices. Such devices are not required, but if implemented, must comply with the requirements defined in this section. The general device requirements are defined in "General Input Device Requirements" earlier in this chapter.

Note to Reviewers: We are interested in your comments on the industry direction for Smart Cards.

[13.38] Smart card reader complies with ISO 7816

A smart card reader must comply with the following ISO specifications:

?? ISO 7816-1:1987 Identification cards—Integrated circuit(s) cards with contacts—Part 1: Physical characteristics

?? ISO 7816-2:1988 Identification cards—Integrated circuit(s) cards with contacts—Part 2: Dimensions and location of the contacts

?? ISO/IEC 7816-3:1997 Information technology—Identification cards—Integrated circuit(s) cards with contacts—Part 3: Electronic signals and transmission protocols

[13.39] Smart card reader supports ISO 7816 T=0 and T=1 protocols

A smart card reader must support the asynchronous protocols T=0 and T=1 as described in ISO 7816-3, either in hardware or in the driver for the operating system. Both protocols must be supported fully. The smart card reader and the driver must support cards that can handle both protocols.

The following protocol rules apply for the T=1 protocol:

?? A transmission is defined as sending a command to a smart card using one or more T=1 blocks and receiving the corresponding answer using one or more T=1 blocks as defined in ISO 7816-3.

?? For cards that support IFSC requests, the very first transmission—after a reset of the smart card—must start with an Information Field Size Device (IFSD) request, as defined in ISO 7816-3, Amendment 1, Section 9.5.1.2.

For cards that do not support an IFSD request (that is, the card replies with an R-Block indicating "Other error"), the transmission must continue with an I-Block.

After a successful RESYNCH request, the transmission must restart from the beginning with the first block with which the transmission originally started.

Support for protocols other than T=0 and T=1 is optional.

[13.40] Smart card reader supports inverse-convention smart cards

A smart card reader must support inverse-convention smart cards either in hardware or in the driver for the operating system.

[13.41] Smart card reader supports 258-byte packets in T=0 and 259-byte packets in T=1

A smart card reader must support the exchange of the following in a single transmission:

?? 258 byte packets in T=0—that is, 256 data bytes plus the two status words SW1 and SW2

?? 259 byte packets in T=1—that is, 254 INF bytes plus NAD, PCB, LEN, and two EDC bytes

[13.42] Smart card reader supports a smart card insertion/removal monitor

A smart card reader must be able to detect and report smart card insertions and smart card removals without any user intervention other than removing or inserting the smart card itself. Preferably, the reader uses an interrupt mechanism to report the smart card insertion/removal to the system. A driver polling method to detect smart card insertion and removals is not recommended.

[13.43] Smart card reader supports PTS

To support multi-protocol smart cards and smart cards using higher data rates and higher clock frequencies, the reader must support protocol type selection (PTS) according to ISO 7816-3 (1997-12-15) Section 7.

[13.44] Smart card reader supports 3.5795 MHz minimum clock frequency

A smart card reader must support a minimum clock frequency of 3.5795 MHz.

[13.45] Smart card reader supports 9600 bps minimum data rate

A smart card reader must support a minimum data rate of 9600 bits per second.

[13.46] Smart card reader supports the Power Down command

A smart card reader must support the Power Down command to turn off power of a smart card, as defined in ISO 7816-3 (1997-12-15) Section 5.4.

~~**13.47. [DELETE] Smart card reader does not use an additional power supply**~~

Note to Reviewers: Recommendations are not included in PC 2001

Plug and Play and Bus Design for Input Devices

The items in this section are requirements for Plug and Play capabilities.

[13.48.] [REDUNDANT] Each device has a unique Plug and Play device ID

Note to Reviewers: These are basic PC 2001 requirements

[13.49.] [REDUNDANT] Dynamic resource configuration is supported for all devices

[13.50.] [REDUNDANT] Each device complies with its device class power management reference specification

[13.51.] [REDUNDANT] Device supports wake-up events

Device Drivers and Installation for Input Devices

[13.52.] [REDUNDANT] Device drivers and installation meet PC 2001 requirements

Note to Reviewers: This is a basic PC 2001 requirement

[13.53] All PC 2001 input devices support Microsoft DirectInput and work simultaneously

All input devices implemented in a PC 2001 system must have drivers that support Microsoft DirectInput if they do not use drivers that are built into the operating system. Also, all input devices must be able to correctly provide simultaneous input. Thus, no input device is disabled automatically when another input device is in use.

Note: The built-in drivers provided with Windows 98 and Windows 2000 meet this requirement.

For information about implementing drivers that support simultaneous use of devices, see the Microsoft DirectInput DDK provided with the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/di_ddk_9rxw.htm).

Checklist for Input Devices

[NEW.13.101] All non-integrated input devices meet USB HID specifications

[13.7] Devices use USB or external bus connections rather than legacy serial or parallel ports

[13.8] [REDUNDANT] All devices meet PC 2001 general device requirements

[13.9] Serial port meets device class specifications for its bus

[13.10] If implemented, legacy serial port is implemented as 16550A UART or equivalent and supports 115.2K baud

[13.11] If implemented, legacy serial port supports dynamic resource configuration

[13.12] If legacy serial port is implemented, conflict resolution ensures availability of at least one serial port

[13.13] Parallel port meets device class specifications for its bus

[13.14] If a legacy parallel port is implemented, flexible resource configuration is supported for each parallel port

[13.15] If a legacy parallel port is implemented, EPP support does not use restricted I/O addresses

[13.16] If a legacy parallel port is implemented, compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications

[13.17] If a legacy parallel port is implemented, port connectors meet IEEE 1284-I specifications, minimum

[13.18] If a legacy parallel port is implemented, IEEE 1284 peripherals have Plug and Play device IDs

[13.20] If implemented, daisy-chained parallel port device is Plug and Play capable

[13.21] Pointing-device connection meets requirements for its bus class

[13.23] Keyboard connection meets requirements for its bus class

[13.24] No interference occurs between multiple keyboards

[13.25] If implemented, Windows and Application logo keys meet Microsoft guidelines

13.26. [REDUNDANT] Game-control device meets USB HID class specification requirements

[13.27] IR device uses NDIS 5.0 miniport driver

[13.28] IR device meets IrDA specifications

[13.29] [REDUNDANT]IR device meets PC 2001 bus and port specifications

[13.30.] [REDUNDANT] IR device supports dynamic resource configuration

[13.31.] [REDUNDANT] IR device meets USB guidelines for interfacing with IrDA Data and IrDA Control devices

[13.32] System supports standard input speeds of 4 Mb/s

[13.33] System provides a separate, physically-isolated transceiver for each IR protocol supported

[6.10] If implemented in a mobile PC, IR devices support power management

[13.38] Smart card reader complies with ISO 7816

[13.39] Smart card reader supports ISO 7816 T=0 and T=1 protocols

[13.40] Smart card reader supports inverse-convention smart cards

[13.41] Smart card reader supports 258-byte packets in T=0 and 259-byte packets in T=1

[13.42] Smart card reader supports a smart card insertion/removal monitor

[13.43] Smart card reader supports PTS

[13.44] Smart card reader supports 3.5795 MHz minimum clock frequency

[13.45] Smart card reader supports 9600 bps minimum data rate

[13.46] Smart card reader supports the Power Down command

[13.48.] [REDUNDANT] Each device has a unique Plug and Play device ID

[13.49.] [REDUNDANT] Dynamic resource configuration is supported for all devices

[13.50.] [REDUNDANT] Each device complies with its device class power management reference specification

[13.51.] [REDUNDANT] Device supports wake-up events

[13.52.] [REDUNDANT] Device drivers and installation meet PC 2001 requirements

[13.53] All PC 2001 input devices support Microsoft DirectInput and work simultaneously

CHAPTER 10A

Graphics Adapters

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IIMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter presents the requirements for the graphics subsystem, video and broadcast components, and related adapters.

The key design goal is to ensure that graphics and video hardware behave consistently across a wide range of applications, based on the need of the system to provide fast, high-quality rendering.

For exceptions and guidelines for the internal graphics subsystem on mobile PCs, see "Mobile PC Graphics Design" at the end of this chapter.

Graphics Guidelines

This subsection covers basic graphics guidelines, including resolution and color depth plus 2-D and 3-D acceleration.

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions.

Baseline Graphics Features

This section defines the basic guidelines for graphics adapters and the graphics subsystem. It covers requirements for display resolution, color depth, refresh frequency, 2-D acceleration, 3-D acceleration, Multi-monitor support, and support for digital displays. Specific requirements are documented in other sections of this chapter.

~~14.10~~14.1 Primary graphics adapter uses ~~PCI,~~ AGP 2X or another high-speed connection

Note to Reviewers: PCI devices will only be allowed for secondary display.

~~OEMs are encouraged to use an~~ Accelerated Graphics Port (AGP) ~~4X attachment with optional sideband addressing and double-clocked data transfer mode, as~~ requirements are defined in *Accelerated Graphics Port Interface Specification, Revision ~~1.0~~2.0* or later, plus PC 2001 requirements defined in "AGP Requirements" later in this chapter.

Notes:

?? Specific 3-D performance requirements are listed in guideline 14.27.

?? Other buses may be used for secondary graphics adapters.~~In all cases, PCI adapters can be used as secondary graphics adapters.~~

Note to Reviewers: Please provide input on specific requirements for integrated parts.

~~**Note:** It is anticipated that AGP, or an integrated graphics subsystem that meets or exceeds AGP performance levels, will be required for all system types in the next version of this design guide.~~

14.2 Desktop system provides hardware-accelerated 3-D graphics

Many of the level of quality features being implemented in GDI+ as well as enhanced user interface features planned for PC 2001 systems will rely on Microsoft DirectDraw and Direct3D being fully implemented in the graphics subsystem. Accordingly, all systems must include DirectX acceleration for 2-D and 3-D.

The graphics adapter requirements on PC 2001 systems that implement 3-D acceleration are defined in "Hardware Acceleration for 3-D Graphics" later in this chapter.

For all systems, 3-D acceleration is based on Direct3D capabilities provided in the operating system.

Systems designed as Windows graphics workstations must include a 3-D accelerator that supports Direct3D and may optionally support OpenGL as well. All hardware accelerated features of the OpenGL accelerator must be accelerated under Direct3D except for those features not supported by the current released version of Direct3D. OpenGL support can be implemented under Windows as a Mini Client Driver (MCD) or Installable Client Driver (ICD). OpenGL driver support for Windows 98 can only be implemented as an ICD.

Implementation details for OpenGL and DirectX are contained in the Windows 98 DDK and Windows 2000 DDK.

14.3 System uses WC with higher-performance processors

Note to Reviewers: Please provide input for hardware requirements for this item.

Write combining (WC) of successive stores to the frame buffer is a requirement for systems with processors that support write combining.

[New.14.102] If Digital Video interface is implemented, it conforms to DVI specification

DVI is the required interface for connecting monitors utilizing a digital interface. For analog video output, the DVI connector analog feature is the preferred connector for monitors with analog interfaces.

A digital monitor interface, regardless of the display technology, will become increasingly important for content copy protection. A future revision of the DVI specification will enable this feature. It is likely that all graphics adapters will be required to support a DVI digital interface when copy protection becomes mandatory.

14.4 Primary graphics adapter works normally with default VGA mode driver

The default VGA driver is required for installing the operating system. The primary adapter must support 4-bit planar VGA mode as described in the Windows 98 DDK and the Windows 2000 DDK. The adapter must also support VGA Text Mode 3. Because digital monitors usually do not support text modes, the adapter must be able to emulate Text Mode 3 for such connections.

14.5 Adapter and driver support multiple adapters and multiple monitors

System expansion buses that allow graphics adapters such as PCI and AGP can support the simultaneous use of more than one graphics adapter in the system. Each graphics adapter can support one or more attached monitors, but this is not a requirement. Multiple-monitor support can be implemented using add-on PCI graphics adapters.

The device drivers for each graphics adapter must provide the required support to allow the presence of multiple adapters and multiple monitors. The hardware and BIOS support consist of Plug and Play-related configuration and resource requirements that ensure automatic support for use of more than one graphics adapter and for simultaneous display on two or more monitors. For details, see "Multiple-Adapter and Multiple-Monitor Support" later in this chapter.

~~*Mobile PC Note*~~

~~For mobile PCs, multiple adapter support is not required unless the mobile PC supports a full docking station, for example, with PCI expansion slots, or the system supports multi-head multi-monitor capabilities. unless the mobile system supports a full docking station. For information, see requirement 6.20, "Mobile system meets Mobile PC 99 requirements for supporting multiple adapters and multiple monitors."~~

14.6 [DELETE] Adapter supports television output if system does not include large-screen monitor

14.7 [Redundant] Adapter meets PC 2001 general device requirements

Note to Reviewers: This is a basic requirement for all devices, so it is no longer repeated here

14.8 ~~Desktop s~~Screen resolution and local memory capacity meet PC 2001 minimum requirements

~~The adapter must support all required resolutions, including:~~

~~640 × 480 × [8, 15 or 16, 24 or 32] bpp~~
~~800 × 600 × [8, 15 or 16, 24 or 32] bpp~~
~~1024 × 768 × [8, 15 or 16, 24 or 32] bpp~~

~~The following resolutions are recommended:~~

~~1280 × 1024 × [8, 15 or 16, 24 or 32] bpp~~

~~1600 x 1280 x [8, 15 or 16, 24 or 32]bpp~~

~~It is acceptable to implement either 15-bit or 16-bit color mode, and it is also acceptable to implement either 24-bit or 32-bit color modeThe 32-bit mode is preferred required rather than the 24-bit mode because it provides more spare8 bits for alpha blending capability.~~

All PC 2001 systems, except for the Mobile PC built-in graphic subsystem, must support a minimum resolution of 1024 × 768, 32 bpp, double buffered in 2-D mode and provide for rendering buffers of up to 1024 × 768 × 16-bit bpp (double-buffered), 16-bit Z buffering in 3-D mode. It is anticipated that 32bpp and 32-bit Z are anticipated to be required for 3-D in future design guides.

All PC 2001 systems must support a minimum resolution of 1024 x 768 x 32 bpp, double buffered in 2D mode with a 32-bit Z buffer (defined as 24-bit Z with 8-bit stencil) in 3D mode.

Integrated Component Note

Until January 1, 2002, designs based on components where the graphics is integrated into either the core logic (North Bridge) or the CPU are not required to support destination alpha blendingmay support a reduced configuration with minimum desktop resolution of 1024 x 768 at a color depth of 24 bpp for 2D and 1024 x 768 at a color depth of 16 bpp with a 16-bit Z buffer in 3D mode. From January 1, 2002 and on, integrated components must meet the same requirements as discrete components.

, and a X.Y MB texture cache. This requires an effective memory footprint of approximately 3 MB. For AGP-enabled systems, which store and execute textures directly from AGP system memory, there is no texture cache requirement.

Designs should provide sufficient 3-D texture access to meet the 3-D performance recommendations defined in requirement 14.34, "Hardware meets PC 2001 3-D accelerator performance requirements."

Texture compression can provide additional effective texture memory; it also increases the effective memory bandwidth that is available.

Mobile PC Note

Mobile systems must support the capabilities listed above that meet the capabilities for the attached LCD panel and equal to or lower than that resolution for any attached external monitor. Mobile PCs that implement a single-chip multi-head configuration must meet the above resolution (not color depth) requirements for any attached monitor independent of the LCD panel's capabilities.

14.9 Adapter meets industry VESA specifications for External Display Interfaceergonomic timing rates

Display adapters often implement more than one display interface (for example, VGA and DVI, VGA and NTSC, Dual VGA, DVI and NTSC, and so on). Each interface that is implemented must comply with the appropriate industry specification (or specifications) for that interface as cited below.

?? Analog VGA: Output must support a minimum of 85 Hz , (non- interlaced at the specified minimum resolution (1024 × 768), non-interlaced..

For mobile PCs, see "Mobile PC Graphics Design" at the end of this chapter.

The graphics adapter must support, at a minimum, the 85 Hz ergonomic timings for all resolutions supported by the monitor up to 1024 × 768. As documented in the current version of *VESA and Industry Standards and Guidelines for Computer Display Monitor Timing*, higher timings and resolutions are preferable under standards published by Video Electronics Standards Association (VESA). Additionally, in order to provide optimal support for video playback in either NTSC or PAL the display adapter must support the appropriate NTSC (59.94 Hz) or PAL (50 Hz) refresh rate to assure smooth frame delivery in TV-based video content applications.

?? Digital Visual Interface: must implement the timings as specified in the current revision of the Digital Visual Interface Specification provided by the Digital Display Working Group.

~~For TV-enabled systems, in addition to the standard VESA timings, it is also necessary to support the 59.94-Hz variants of the 60-Hz timings. This is important for smooth frame delivery in TV video applications.~~

Notes:

?? Single-chip multi-head devices that support independent displays must be able to meet this requirement on both displays simultaneously and independently—for example, 85 Hz on the PC monitor while displaying NTSC TV out or DVI.

~~For flat-panel displays for desktop or mobile use, it is not necessary to implement refresh rates higher than 60 Hz. For additional exceptions and requirements for mobile PC systems, see "Mobile PC Graphics Requirements" in Chapter 6, "Mobile PC 99."~~

?? Regarding interlaced display modes: When the user selects 1024 × 768 resolution, the graphics adapter must default to a non-interlaced refresh rate. A graphics adapter can default to 1024 × 768 interlaced mode in either of the following situations:

The attached monitor is not DDC-compatible and the user has not selected a monitor type in the display control panel.

The monitor does not support 1024 × 768 non-interlaced mode, as determined from the Extended Display Identification Data (EDID) or monitor registry settings.

14.10 All supported color depths are enumerated

The driver must enumerate all modes supported so that applications can choose their preferred color depth. The driver must comply with the following guidelines for enumeration:

?? For 16 bpp, either the 5:5:5, 5:6:5, or both modes must be supported.

?? If only the 5:5:5 mode is supported, the driver must also enumerate this as 16-bpp mode. This is required because some applications only look for 16-bpp support and will run in 8-bit mode if they fail to find a 16-bit mode.

?? If both 5:5:5 and 5:6:5 modes are supported, both modes must be enumerated.

For each color depth supported, color ordering must be implemented as shown in the following list. Color ordering is shown in the following list from the most significant bit (MSB) to the least significant bit (LSB.)

Mode	Color ordering
15 bpp	1 undefined, 5 red, 5 green, 5 blue (URRR RRGG GGGB BBBB)
16 bpp	5 red, 6 green, 5 blue (RRR RRGGG GGGB BBBB)
~~24 bpp~~	~~8 red, 8 green, 8 blue (RRRR RRRR GGGG GGGG BBBB BBBB)~~
32 bpp	8 alpha, 8 red, 8 green, 8 blue (AAAA AAAA RRRR RRRR GGGG GGGG BBBB BBBB)

14.11 Graphics operations use relocatable registers only

VGA registers must not be used to perform graphics operations such as bit blting, palette setting, and pointer movement. The registers used for these graphics operations can be either I/O locations or memory-mapped locations, but must be relocatable. Normal system operation should never require use of base VGA registers, except for system startup and mode setting.

DirectDraw and Direct3D functionality must be independent of VGA. This means that graphics require VGA only for initialization.

14.12 Adapter supports adjustable gamma correction ~~Adapter supports downloadable RAMDAC entries for integrated color management~~

Integrated Color Management (ICM) uses this capability to perform Gamma correction for the attached monitor and to allow game applications to switch palettes. This capability also supports transition effects in applications. To provide support for ICM the graphics adapter gamma ~~curves~~ must be programmatically adjustable. It is ~~recommended~~ required that ~~for graphics adapters that support 32bit or higher displays,~~ downloadable RAM digital-to-analog converter (RAMDAC) entries ~~should~~ be included to perform gamma correction in hardware at 24 bpp.

This capability must be supported without requiring the use of any VGA resources as ~~the related requirement to use VGA only for system initialization~~ defined in requirement 14.11, “Graphics operations use relocatable registers only.”~~Integrated color management (ICM) uses this capability to ensure that gamma is correct in the monitor and to allow game applications to switch palettes. This capability also supports transition effects in Internet Explorer 5.0 and other applications.~~

14.13 Adapter for external display supports ~~DDC~~ Plug and Play monitor detection

This requirement is based on the *Display Data Channel Standard, Version 3.0* (DDC), which defines the communication channel between the display and host system. The software can use this information to properly manage output to the various displays and to prevent the disabling of television output if no monitor is attached. Devices capable of multi-head display must support this feature for all attached monitors.

Note: Implementation of DDC detection for internal displays will be required when an appropriate standard is developed. Although systems are not presently required to support plug and play detection of the internal display if it is non-detachable, it is highly desirable that this be supported going forward in order to provide the best possible user experience. Because a wide range of LCD and other flat panel display types may be implemented, the characteristics of the display panel must be made available to the system in order to optimize the quality of the display output.

~~Mobile systems are not required to support DDC monitor detection of the display if the display is permanently attached and connected using an internal interface. However, such systems must support DDC for the external monitor interface port.~~

14.14 [moved] Hardware supports video overlay surface with scaling

14.15 [moved] Hardware supports VGA destination color keying for video rectangle

14.16 [moved] Hardware supports alpha blending of graphics and video

14.17 [moved] Video port meets specifications if present on graphics adapter

Note to Reviewers: These items moved to the "Graphics Subsystem Support for Video" section later in this chapter.

14.18 [DELETE] Hardware supports MPEG-2 motion compensation acceleration

Note to Reviewers: Recommendations are not included in PC 2001.

14.19 [DELETE] Hardware supports scanning at the same frequency as the incoming video

Note to Reviewers: Recommendations are not included in PC 2001.

Multiple-Adapter and Multiple-Monitor Support

This section defines the requirements for ensuring system support for multiple adapters and multiple monitors. This support ensures that if the user adds a

second adapter, resources will automatically be available and the operating system can automatically manage multiple display adapters.

The actual implementation a user might employ could be one of the following:

?? Multiple adapters added to the PC system

?? A single adapter with a single controller supporting two monitors (single- chip multi-head)

?? A single adapter with multiple controllers supporting multiple monitors (multi-head)

?? Any combination of these scenarios

Multi-monitor support requires multiple-adapter/ multiple-monitor compatibility in the BIOS, plus the graphics adapter and its driver. This support also requires allowing any secondary graphics adapters to be enabled in VGA mode, thus requiring that VGA for the previous adapter be temporarily disabled.

With this support, a single adapter that supports multiple monitors can display independent screen images. The operating system support therefore also assumes that the different displays might have differing X, Y coordinates, resolutions, color depths, refresh rates, and display capabilities.

For technical details about implementing driver support for multiple adapters and multiple monitors, see the Windows 98 DDK and the Windows 2000 DDK.

14.20 Extended resources can be dynamically relocated after system boot

To ensure Plug and Play for multiple-adapter/multiple-monitor capabilities, all non-VGA standard display resources, also known as extended resources, such as register sets and so on, must be capable of being dynamically relocated after system boot (after POST).

This is an extension of requirement 14.11, “Graphics operations use relocatable registers only,” plus the general Plug and Play requirements.

14.21 VGA resources can be disabled by software

A means must be provided to allow a driver to disable its adapter from decoding standard VGA addresses to ensure that the adapter is independent of all other graphics adapters in the system. The adapter must remain fully functional without the VGA addresses. See also requirement 14.11, “Graphics operations use relocatable registers only.”

Hardware Acceleration for 2-D Graphics

This section summarizes guidelines related to 2-D ~~DirectDraw~~ graphics features, which can be implemented as hardware acceleration features.

All PC 2001 systems require hardware acceleration for 2-D graphics. Robust DirectDraw support is also required to allow 3-D hardware accelerators to take full advantage of the DirectX architecture.

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.7.

14.22 Frame buffer can be accessed directly by applications

The visible frame buffers must be accessible. It must be possible for applications to perform direct frame buffer accesses at any time, even while asynchronous accelerator operations are being executed. Without this capability, drivers cannot support DirectDraw or Direct3D on Windows 2000, and operations on Windows 2000 will not be fully robust.

~~Some hardware keeps the information in its frame buffers in a format that does not correspond to the linear format standard in DirectDraw, such as tiling the pixels to exploit the 2-D coherence of image data. If this is the case, the hardware must perform translations so that DirectDraw surfaces being accessed directly appear linear. The hardware performing this translation might be a limited resource, but it must be able to perform translations on at least seven DirectDraw surfaces simultaneously. Support for eight or more surfaces is recommended.~~

14.23 Adapter and driver support linear-mapped, low-resolution modes

All graphics adapters currently support linear-mapped low-resolution modes, with minimal driver work needed to support this requirement. Decreasing the size of the frame buffer decreases the average polygon size and increases the frame rate for a given scene. These additional modes provide support software rendering for games and software Direct3D.

If low-resolution support is implemented in the hardware, the following low-resolution modes are required:

320 × 200 × 16 bpp	320 × 240 × 16 bpp	640 × 400 × 16 bpp
320 × 200 × 8 bpp	320 × 240 × 8 bpp	640 × 400 × 8 bpp

~~The following low-resolution modes are recommended:~~

~~400 × 300 × 16 bpp~~	~~512 × 384 × 16 bpp~~
~~400 × 300 × 8 bpp~~	~~512 × 384 × 8 bpp~~

Note: In Windows 98, low-resolution capabilities must not be defined in the registry so that they do not appear in the display control panel. In Windows 2000, the control panel automatically filters out these modes.

14.24 Hardware supports transparent blter

There is no restriction on source size. A transparent blter can perform a blt with a source key transparent color. This assumes that the blter is asynchronous with the host processor.

14.25 Hardware provides support to prevent tearing

The hardware must support a mechanism for preventing visible artifacts such as "tearing." The mechanism for doing this is at the discretion of the hardware designer, but it must support tear-free capabilities for both full-screen and non-occluded windowed applications. Only one of two simultaneous displays of the same image on two displays (for example, internal mobile panel and external VGA monitor attached) must meet this requirement.

The mechanism to prevent tearing must be performed in synchronization with the VBI.

Except when explicitly requested to do otherwise by an application (via DirectDraw), blts must be performed in synchronization with the vertical scan line to avoid tearing. The ability to read the current scan line supports blting or writing to the screen without tearing. In some contexts, such as video playback, this support eliminates the need for the secondary overlay buffer. Other exceptions to this requirement may be allowed and will be documented in the Windows 2000 DDK.

For information about the upper limits of resolution to be supported, see requirement 14.8, "Screen resolution and local memory capacity meet PC 2001 minimum requirements."

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.7.

14.26 [DELETED] ~~Hardware supports programmable blter stride~~

~~This is required as part of the support for textures. A programmable blter stride ensures that Windows can use linear memory. A fixed stride forces Windows to use rectangular memory management, with all the related inefficiencies. It must be possible to specify different strides for the source and destination on blts.~~

Hardware Acceleration for 3-D Graphics

This section summarizes guidelines related to Microsoft Direct3D technologies that can be implemented as hardware acceleration features. Supporting the items in this section results in improved performance and improved memory use. ~~Support for 3-D graphics is required by mainstream business applications plus educational, entertainment, and other applications including the Internet Explorer shell for both Windows 2000 and Windows 2000 Professional.~~

~~All systems except for mobile systems are required to support 3-D acceleration in the graphics subsystem. Each entry in this section indicates by system type whether a particular feature must be implemented if the graphics adapter includes 3-D support.~~

~~For exceptions and requirements for mobile PCs that implement 3-D hardware acceleration, see "Mobile PC Graphics Requirements" in Chapter 6, "Mobile PC 99."~~

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.7.

14.27 Hardware for desktop system supports ~~required~~ RGB rasterization

In RGB mode under Direct3D, shading across a surface is accomplished by independently interpolating all color components. The following capabilities are required for red-green-blue (RGB) rasterization:

?? **14.27.1 [REDUNDANT] ~~Basic 3-D requirements.~~** ~~To meet basic 3-D requirements, the adapter and driver must do the following:~~

~~? Support 800 × 600 × 16 bpp, double-buffered, with 16-bit Z-buffer at 75Hz in full-screen, 3-D graphics mode~~

~~? All required features must be available at the same time; for example, it is not acceptable to turn off specular highlights in order to enable fog~~

~~? Conform to Direct3D rasterization rules~~

Note to Reviewers: This material is redundant with other sections.

?? **14.27.2 Textures.** These include the following:

?? MIP-mapped textures

?? Bilinear or better filtered textures, rather than point-sampled, with perspective correction

~~? Anisotropic filtering~~

?? **14.27.3 Alpha blending for 3-D graphics.** Source alpha blending is required~~, and destination alpha blending is recommended~~.

Support for source alpha blending (e.g. the blend operation does not require an alpha channel in the render target) and destination alpha blending (e.g. the blend operation requires an alpha channel in the render target) is required for all devices

The following table shows the blend modes that must be supported as source and destination factors for alpha blending. All modes must be available in any combination and without dependency on other modes:

Blend Mode	Source Factor	Destination Factor
D3DBLEND_ZERO	Yes	Yes

D3DBLEND_ONE	Yes	Yes
D3DBLEND_SRCCOLOR	N/A	Yes
D3DBLEND_INVSRCCOLOR	N/A	Yes
D3DBLEND_SRCALPHA	Yes	Yes
D3DBLEND_INVSRCALPHA	Yes	Yes
D3DBLEND_DESTALPHA	Yes	Yes
D3DBLEND_INVDESTALPHA	Yes	Yes
D3DBLEND_DESTCOLOR	Yes	N/A
D3DBLEND_INVDESTCOLOR	Yes	N/A
D3DBLEND_SRCALPHASAT	Yes	N/A
D3DBLEND_BOTHSRCALPHA	Yes	N/A
D3DBLEND_BOTHINVSRCALPHA	Yes	N/A

Yes = Required **N/A** = Not applicable

Note: See the DirectX DDK for driver implementation details and a description of the blend modes.

Integrated Component Note

Until January 1, 2002, designs based on components where the graphics is integrated into either the core logic (North Bridge) or the CPU are not required to support destination alpha blending. From January 1, 2002 and on, integrated components must meet the same requirements as discrete components.

~~**Required**~~ ~~**Recommended**~~

?? ~~As a minimum, the following source blend modes are defined in the DirectX DDK are required:~~

~~D3DBLEND_DESTCOLOR~~
~~D3DBLEND_INVDESTCOLOR~~
~~D3DBLEND_ONE~~
~~D3DBLEND_ZERO~~
~~D3DBLEND_BOTHINVSRCALPHA~~
~~? D3DBLEND_BOTHSRCALPHA~~
~~D3DBLEND_INVSRCALPHA~~
~~D3DBLEND_INVSRCCOLOR~~
~~? D3DBLEND_SRCALPHASAT~~
~~D3DBLEND_SRCALPHA~~
~~D3DBLEND_SRCCOLOR~~

~~D3DBLEND_DESTALPHA~~
~~D3DBLEND_INVDESTALPHA~~

~~For source RGB alpha blending, transparent primitives are blended with the background, but the background transparency is not updated. This method provides good visual accuracy if there are not too many overlapping transparent objects.~~

~~If destination alpha blending is implemented, the following destination modes are required:~~
~~D3DBLEND_SRCCOLOR~~
~~D3DBLEND_INVSRCCOLOR~~
~~D3DBLEND_ONE~~
~~D3DBLEND_ZERO~~

~~For destination RGB alpha blending, primitives are blended with the background, updating not only the colors in the frame buffer but also a cumulative transparency that can affect the rendering of subsequent primitives.~~

?? **14.27.4 Lighting and fogging.** These requirements include the following:

?? Flat and Gouraud shading.

?? Depth-based (Z-based) fog of an arbitrary color, calculated on a per-pixel ~~vertex~~ basis. Depth is defined as distance perpendicular to the screen.

?? Specular highlighting.

The Direct3D reference rasterizer provided in DirectX 5.0 and later supports all of these capabilities.

There is no requirement for edge anti-aliasing.

Integrated Component Note Until January 1, 2002, designs based on components where the graphics is integrated into either the core logic (North Bridge) or the CPU may support per-vertex fog rather than per-pixel~~are not required to support destination alpha blending~~. From January 1, 2002 and on, integrated components must meet the same requirements as discrete components.

14.28 Hardware for desktop system supports~~recommended~~ RGB rasterization features

Note to Reviewers: This item will be combined with the previous in the next draft.

The required RGB rasterization features include the following:

?? Range-based or table-based fog

?? Hardware support for triangle strips and fans

~~Support for the following is encouraged, but not required:~~

~~? Sort independent edge anti-aliasing~~

~~? Precision line drawing (Bresenham line drawing algorithm recommended)~~

14.29 Hardware supports multi-texturing

Multi-texturing hardware can apply multiple textures to a polygon. The most common application of multi-texturing is with map-based techniques for diffuse lighting and specular reflections.

Implementing this capability requires supporting two or more sets of independent texture coordinates. ~~It is recommended that hardware supports combining at least two textures in a single pass.~~

The following texture combination operations are required:

?? MODULATERGB: Component-wise multiplication of both texture colors.

?? MODULATELPHA: Multiply colors of one texture by the alpha of the other.

?? ADD: Component-wise addition of both textures.

?? BLEND: Linear combination of textures weighted by a scalar specified in a register or in a polygon alpha.

Multi-texturing is used to compute the texture value that participates in the pixel pipeline implemented in Direct3D~~ in DirectX 5.0. It is independent of the alpha blending stage in a previous version of Direct3D~~.

This technique must work in combination with fogging and alpha blending, but is not required to operate at the same time as other advanced filtering.

For more information, see the paper on multi-texturing and DirectX available on the web site at http://www.microsoft.com/hwdev/video/.

14.30 Hardware supports texture formats

Hardware that implements 3-D acceleration must support palletized textures. Pallet entries use the corresponding nonpalletized formats shown in the following table.

Required	~~**Recommended**~~
1:5:5:5 ARGB	~~48-bit palletized~~
4:4:4:4 ARGB	~~8:8:8:8 ARGB~~
8:8:8:8 ARGB	~~0:5:6:5 ARGB~~
	~~4:2:2 YUV~~

Integrated Component Note

Until January 1, 2002, designs based on components where the graphics is integrated into either the core logic (North Bridge) or the CPU are not required to support the 8:8:8:8: ARGB format. From January 1, 2002 and on, integrated components must meet the same requirements as discrete components.

14.31 Hardware complies with texture size limitations

MIP mapping requires that textures of size 1 × 1 be supported. To meet PC 2001 requirements, a 3-D accelerator must support this lower limit on texture size.

The texture units must support square and non-square power-of-two textures (2n × 2m) up to 1024 × 1024. If implemented, support for non-power-of-two width and height allows the texture-mapping unit to be used to emulate blts.

~~The texture units must support square and non-square power-of-two textures ($2^{n} \times 2^{m}$) up to 256 × 256.~~

~~Recommended: The texture unit should support non-power-of-two width and height. This enables the texture-mapping unit to be used to emulate blts. Also, it is recommended that the texture unit support an upper limit of 2048 × 2048 rather than the required 256 × 256.~~

~~*Mobile PC Note*~~ ~~Mobile systems must support square texture sizes of up to 256 × 256 only.~~

14.32 [DELETED]~~Hardware supports destination RGB alpha blending~~

14.33 Hardware for desktop system supports Z comparison modes and Direct3D-compatible formats

The 3-D hardware must support 32-~~16~~-bit (24-bit Z and 8-bit stencil) ~~minimum~~, unsigned, lockable Z buffer format and all Z comparison modes.

Hardware that supports Z buffering must support clearing of the Z buffer through the DirectDraw depth-fill blt mechanism. Additionally, DirectX 5.0 (and later versions) enables Z buffers to be cleared at the same time as destination surfaces, so hardware must support simultaneous clearing of color and Z buffers using this method as well.

Integrated Component Note Until January 1, 2002, designs based on components where the graphics is integrated into either the core logic (North Bridge) or the CPU may support a reduced configuration with a 16-bit Z buffer instead of a 32-bit Z buffer. From January 1, 2002 and on, integrated components must meet the same requirements as discrete components.

~~*Mobile PC Note*~~ ~~Mobile systems must support the capabilities listed above to the extent of the capabilities of the attached LCD panel.~~

~~14.34 Hardware for desktop system meets PC 2001 3-D accelerator performance requirements~~

~~The 3-D rendering subsystem should have triangle setup capability implemented in hardware that is capable of processing triangles at a sustained rate in excess of 12 million triangles per second.~~

~~Each triangle is assumed to be 1 visible pixel in area, random-orientation, front facing, single-textured, and composed of three vertices, where each vertex contains a diffuse and specular color component. Rendering conditions should must be 3216 bpp, double-buffered, Gouraud-shaded bilinear single-textured, Z buffered (24-bit Z with 8-bit stencil), and alpha blended. Triangles should must~~

be ordered such that the Z check always passes (the current triangle is in front of all previously rendered triangles).

The 3-D rendering subsystem must be capable of filling triangles at a sustained rate in excess of 4080 million pixels per second. Each triangle is assumed to be 10,000 visible pixels in area (post-clipped), with the same attributes as described for triangle setup in the previous paragraph. Rendering conditions are also the same as for triangle setup. Supporting 60 million pixels per second is recommended.

Integrated Component Note Until January 1, 2002, designs based on components where the graphics is integrated into either the core logic (North Bridge) or the CPU are not required to support destination alpha blending. From January 1, 2002 and on, integrated components must meet the same requirements as discrete components.

Mobile PC Note Mobile systems requirements are reduced to 2 million triangles per second and 80 million pixels per second.

Television Output Requirements

This section summarizes requirements for television output capabilities.

The required support allows an NTSC or PAL television to be used as a primaryor secondary display surface for the Microsoft Windows family of operating systems and for Windows-based applications. If television output capabilities are provided in a PC 2001 system, support is required for either NTSC or PAL standards. For more information about world television standards, see the web site at http://www.bbc.co.uk/aberdeen/eng_info/.

Note: The requirements in this section apply only if the television output capability is present on a PC 2001 system or on a graphics adapter that supports television output capabilities. Some television output capabilities listed in this section are required only for Entertainment PC systems.

14.35 [DELETED] Adapter supports both NTSC and PAL output

Note to Reviewers: Recommendations are not included in PC 2001

14.36 [DELETED] Default boot mode supports appropriate locale

14.37 If TV Out is implemented, adapter supports underscan scaling

The television output adapter must be able to correct horizontal and vertical overscan using hardware scaling. This allows 640 × 480 resolution modes to fit onto NTSC displays and 800 × 600 resolution modes to fit onto PAL displays.

Driver software must be capable of enabling and disabling scaling and also of adjusting scaling for compatibility with a variety of television monitors. As television monitors age, overscan reduces, so less scaling is required.

14.38 If TV Out is implemented, adapter supports flicker filter

The television output adapter must use multi-line (3-tap minimum) hardware filtering techniques for flicker reduction. Enable, disable, and adjust capabilities for the flicker filter must be software controllable. Also, overscan must be software controlled.~~enabled when the PC is playing full-screen video. The practice of running the graphics surface at a high resolution and then performing high-quality anti-aliased down scaling to TV resolutions is a good idea and is highly encouraged. For mobile PCs, the television output adapter must use 2-tap minimum hardware filtering techniques or better.~~

The TV Out capability must be able to accept a 1024 × 768 progressive desktop and convert it to an interlaced TV resolution output signal.

14.39 [DELETE] ~~Adapter provides proper termination~~

14.40 If TV Out is implemented, adapter supports composite video~~and S-Video~~ connectors

Support for ~~both~~ composite video is required.~~and S-Video is required for Entertainment PCs and is recommended for other system types.~~

A dongle with a composite video connector meets this requirement if the dongle ships as part of the TV Out solution.

~~In addition, vendors are encouraged to provide support for S-Video and Component Video connectors. Compared to composite video, S-Video dramatically improves the picture quality of the NTSC or PAL scan converter. This standard is designed to reduce cross talk between chrominance and luminance signals, and to increase the luminance bandwidth capability of the television. A further increase in quality is obtained by using component video, which is common in Europe and will become so in North America.~~

~~For information about these standards, see the web site available at http://www.bbc.co.uk/aberdeen/eng_info/.~~

14.41 If TV Out is implemented, adapter with television output supports ~~both~~DVI or VGA and television output

A graphics adapter that supports TV Out must also support either DVI or VGA or both. The usefulness of a system will be greatly enhanced when any combination of outputs can be active concurrently. This will become a requirement in the future. Mobile platforms that support TV Out do not need to support additional VGA or DVI connectors because a flat panel display is already integrated into the platform.

~~In addition to television output, the PC 2001 system must also support VGA output to ensure that users with large-screen VGA monitors can use this output capability.~~

~~It is recommended that The adapter support~~

? Simultaneous output to VGA monitor and television.

? Two display controllers or an implementation that provides the desired result of two independently timed outputs to different monitors.

With a single controller, both the monitor and television must use a 60 Hz, low-resolution format; which is not desirable.

14.42 If TV Out is implemented, software supports positioning

Software must be able to program the television output hardware to position the television image in increments of 4 pixels horizontally and 4 scan lines vertically (or finer).

14.43 [DELETED] software supports detection of television connection

For Consumer PC and Entertainment PC systems,Software must be able to detect whether a television is attached to any of the TV Out connectors. Detection of a VGA monitor is based on requirement 14.13, "Adapters supports DDC monitor detection."Detection of a television connection is required to allow the operating system and graphics drivers to correctly support display output during the startup sequence, for example, determining what resolution and refresh rate to use, and to allow applications to adjust their user interfaces appropriately to the screen capabilities.

14.44 If TV Out is implemented, analog video outputs support copy protection

The use of an appropriate copy protection system is necessary to stop DVD discs from being played on the PC and then recorded on a VCR. make it difficult for typical consumers to make analog recordings of copy protected content, such as protected DVDs.

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Details for MacroVision protection for DVD are available at http://www.macrovision.com.

Plug and Play Requirements for Graphics Adapters

The items in this section summarize requirements for Plug and Play and other resource- and bus-related capabilities. The specifications in this section are required for all PC 2001 systems.

See also requirement 14.11, “Graphics operations use relocatable registers only.”

The requirements in this section ensure easy configuration.

14.45 Display devices do not use VGA BIOS POST to populate PCI Subsystem ID. ~~Each device has a Plug and Play device ID~~

Note to Reviewers: The general PnP device ID requirement is applies for all PC 2001 devices. Title change reflects focus for graphics subsystem

~~The device must have a unique device ID using the format required for its bus. For example, a PCI device must comply with PCI 2.1 and provide a Subsystem ID and Subsystem Vendor ID, as defined in Chapter 9, “PCI.”~~

Multiple-monitor support allows Display class devices to be initialized independent of the system initialization process. For this reason, system-board and add-on display devices cannot use the VGA BIOS POST routine to populate the Subsystem ~~Vendor~~ ID (SSID) because the device’s POST code might not be executed until later in the process, after device enumeration occurs. For system-board devices, the system BIOS must populate the ~~Subsystem Vendor ID~~SSID at power on. Add-on display adapters must provide a method for populating the ~~Subsystem Vendor ID~~SSID at the point when power is applied and the device is initialized to the state that is ready for POST.

14.46 System supports conflict resolution, VGA compatibility, and extended registers

When the end user changes or adds a graphics adapter to the system, setting resource assignments must not require changing jumpers or switches on either the card or the system board. The system must be able to automatically relocate the resources used by a graphics adapter on the system board when a graphics adapter expansion card is added to the system. In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable one of the adapters in order to prevent the system from stalling.

The system must support the VGA graphics standard for application compatibility and for the Windows clean-boot error-recovery process. If a VGA BIOS exists on the graphics adapter, it must be able to configure its base address to C0000h and one alternate address, at a minimum, to prevent conflicts.

Extended resources are additional I/O ports, direct-access frame buffers, or data transfer areas on a graphics adapter that use more resources than does standard VGA. The Windows configuration manager must be able to map the resources to avoid conflicts with other system devices. At least one alternate configuration must be provided for each non-VGA display resource in the event of conflict during the IPL boot.

The software drivers and VGA BIOS (if used) must be able to use alternate configuration register addresses. The system must be able to dynamically disable

or relocate VGA resources from C0000h. It must also be possible to re-enable these resources upon system reboot or reset.

For additional related requirements for multiple monitor support, see "Multiple-Adapter and Multiple-Monitor Support" earlier in this chapter.

BIOS and Option ROM Guidelines for Graphics Adapters

The requirements in this section relate to BIOS support for graphics adapters.

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions.

14.47 Chips support linear packed-pixel frame buffer, relocatable above 16 MB

Note: For DirectDraw, the graphics adapter's chip set must support linear access to the frame buffer by the host.

Windows operating systems are optimized for a graphics adapter with a packed-pixel frame buffer at all supported resolutions. Memory-mapped packed-pixel frame buffers also provide a fast and simple interface between Windows and the graphics adapter. The Windows DIB engine provides a very fast display by writing directly to packed-pixel frame buffers. This architecture requires that the hardware developer write only a small, simple device driver.

For optimized support with Windows, a linear packed-pixel frame buffer is required over a bank-switched frame buffer. Use 32-bit addresses to allow the linear frame buffer to be placed above the 16-MB ISA boundary, which enables a system to be populated with large amounts of RAM.

If memory or other resources conflict with the frame buffer being mapped into a linear address space, the page frame address can be used with minimal degradation of performance.

14.48 Option ROM supports DDC2B

The option ROM for the graphics adapter must meet current DDC2B host requirements documented in *Display Data Channel Standard, Version 3.0,* Level 2B protocol (DDC2B), published by VESA. This standard defines the functions that support the data channel between the graphics adapter and a DDC monitor.

~~*Mobile PC Note*~~

~~This is not a requirement for mobile systems. For information about exceptions for permanently attached display monitors, see requirement X.Y, "External graphics adapter interface supports DDC monitor detection."~~

~~[14.49] [DELETED][MOVED] BIOS setup utility provides option to force use of system-board graphics~~

Note to Reviewers: Recommendations are not included in PC 2001. This becomes a requirement for Mobile Systems.

14.50 BIOS supports large frame buffers for graphics adapters

The BIOS must support large frame-buffer graphics adapters that have up to 256 MB of frame buffers.

Requirements for AGP and PCI Graphics Adapters

The requirements in this section apply for graphics adapters that use the PCI bus.

14.51 AGP meets PC 2001 implementation guidelines

Note to Reviewers: New requirements for AGP may be defined in the next version of these draft guidelines. AGP requirements may also move to the Buses chapter in a future draft.

14.52 ~~PCI~~ Graphics device supports IRQ and correctly populates PCI BARs

Proper IRQ support is needed for optimal support of video playback. The display driver queries the actual device to find its register locations and so on. The PCI base address registers (BARs) must be populated correctly for this information to be correct in the registry.

On adapters that do not support an IRQ, the Interrupt Pin Register (3Dh) must be zero (0).

14.53 ~~PCI~~ System-board graphics device is not hidden from Plug and Play enumeration

The system-board device must disable the PCI device rather than hiding it. Hiding the system-board graphics adapter from the PCI bus when another graphics adapter is detected in the system causes problems for supporting multi-monitor capabilities.

Power Management for Graphics Adapters

This section summarizes the specific power management requirements for graphics adapters.

14.54 Graphics adapter complies with device class power management reference specification

The *Display Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–D3) for display and graphics devices. The specification also covers device functionality expected in each power state and the possible wake-up event

definitions for the class, if any. Power states D0 and D3 are required; D1 and D2 are optional for graphics adapters.

14.55 Graphics adapter complies with VBE/Core 2.0 extensions for power management

The *VESA BIOS Extension Standard/Core Functions 2.0* (VBE/Core 2.0) specification defines extensions to VGA ROM BIOS services for power management.

Device Drivers and Installation for Graphics Adapters and Video Devices

This section summarizes the requirements for graphics adapters. The requirements in this section are required for all PC 2001 devices.

For additional driver-related requirements for multiple-monitor support, see "Multiple-Adapter and Multiple-Monitor Support" earlier in this chapter.

Note: Software provided with graphics adapters designed for use with Windows 2000 must comply with the requirements defined in the drivers section of the Windows 2000 DDK.

14.56 [Redundant] Device drivers and installation meet PC 2001 requirements

Note to Reviewers: This is a basic PC 2001 requirement and is no longer repeated in each chapter.

14.57 Driver does not bypass any Microsoft-provided system components

The driver must not bypass or patch any Microsoft-provided system components. For Windows, this includes Gdi.exe, Kernel.exe, User.exe, Dibeng.dll, Mmsystem.dll, Ddraw.dll, D3d*.dll, and so on.

For Windows 2000, this requirement applies for all files normally installed in the System32 directory. These files include, but are not limited to, Win32k.sys, Ntoskrnl.exe, Gdi32.dll, User32.dll, and Mcdsrv32.dll.

14.58 Applications provided with device meet requirements for Win32-based applications

Any Windows-based applications provided with the device must meet Microsoft requirements for software compatibility as defined in the Microsoft Platform SDK.

14.59 Driver supports dynamic color ~~bit~~ depth and resolution change

The graphics adapter must operate properly and must not fail when asked by the operating system to change the color depth or resolution. A restart must not be required to accomplish this.

Shared Memory Architectures

As integration of graphics into the motherboard chipset becomes common there are several issues that must be addressed in order to have an effective implementation.

Graphics Subsystem Support for Video

This section presents requirements for the graphics subsystem to support TV or DVD video playback.

Note to Reviewers: Details will be provided in a future draft.

14.14 If support for TV or DVD video playback is implemented, hardware supports video overlay surface with scaling

~~*Mobile PC Note*~~ ~~For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.~~

It is envisioned that the overlay surface will be implemented using one of the required YUV formats. The graphics adapter must be able to support a minimum of one off-screen video overlay surface that has following characteristics:

?? **14.14.1 Size.** Support for ~~720 × 576~~1280 × 720 or larger.

~~To support the HD0 formats for DTV – notably 720p24 – it is required to support 1280 × 720 on the Entertainment PC.~~

?? **14.14.2 Screen Resolutions.** The video overlay must be fully operative at a minimum screen resolution of 1024 × 768 at 60 Hz and color depths of ~~8 bpp and 16 bpp.~~16 bpp and 32 bpp.

?? **14.14.3 Color formats.** The required formats must include the following:

?? YUV 4:2:2 YUY2: A packed-pixel byte stream for every pixel in the order of Y1, U, Y2, V is required in ~~both the primary and secondary~~all overlay surface buffers.

?? ~~both the primary and secondary~~YUV 4:2:0 YV12: A system-board byte stream for the entire plane in the order of Y plane, V plane, U plane is required in the ~~secondary~~ final overlay surface buffer when double-buffering is supported.

If double buffering is not supported, YV12 support must be provided in the ~~primary~~ overlay surface.

Support for the YUV 4:2:0 format is not a requirement if the graphics chip supports on-chip MPEG decoding (that is, 75 percent hardware

implementations such as motion compensation and iDCT in hardware solutions, or the equivalent). In this situation, YUV 4:2:0 capability is only a recommendation, although it is still strongly recommended to support software MPEG decoding for secondary video windows.

Mobile PC Note

Mobile PCs and Office PCs that implement TV or DVD video playback features are not required to support the YUV 4:2:0 format.

The YUV color space and intensity range are defined by the ITU-R BT.601-4 standard (previously called CCIR-601), where U is CB and V is CR. These formats use less memory while maintaining high quality, and YUV is the native format for many image and video compression standards.

?? **14.14.4 Scaling.** Upscaling and downscaling to any size window. The high quality video scaling can occur anywhere between the video input to the chip, on the AGP, PCI, or side port, and the video appearing on the screen.

Video scaling must be implemented using the existing DirectDraw and DirectShow APIs.

For PCs to effectively compete with dedicated consumer electronics video devices, it is necessary to raise the quality of video scaling on the PC. Specifying scaling quality is hard because of the difficulty of quantifying viewer-perceived video quality. In the absence of anything better, guidelines for the quality of the video filter used in the resizing operations are specified.

Scaling requirements for video-enabled Office PC or Mobile PC systems:

? Hardware scaling is not a requirement, but bi-linear scaling (two taps vertically and two taps horizontally) is recommended. However, considerable user and marketplace benefits can be gained by implementing the video playback requirements defined for Entertainment PC systems.

? Any hardware scaling engine present on a non-DTV-enabled Office PC is required to be able to accept a standard definition video input (480i or 576i), such as might come from a DVD or NTSC source. For a DTV-enabled Office PC, the requirement is that the scaling engine, if one is present, must be able to accept an input with a rate of 480p60 (720 horizontal pixels) and 720p24 (1280 horizontal pixels).

Scaling requirements for video-enabled Consumer PC system:

?? The minimum requirement is to use bilinear scaling; a filter with two vertical taps and two horizontal taps is required. Vendors are encouraged to implement a minimum of three taps vertically and four taps horizontally and, ideally, four or five vertical and seven or eight horizontal taps.

?? The ability for video display to shrink or zoom by a variable factor of up to 8:1 in one-pixel increments is required.

?? The image quality must not be perceptibly degraded when shrinking by factors up to 2:1. Some image degradation is acceptable for the larger

shrink ratios, although market acceptance of the product will suffer if image quality is excessively degraded.

?? The scaling engine on a non-DTV–enabled Consumer PC must be able to accept a standard definition video input (480i or 576i), such as input that might come from a DVD or NTSC source. For a DTV-enabled PC, the scaling engine must be able to accept an input with a rate of ~~480p60 (720~~720p60 (1280 horizontal pixels) and 540p60 (Bobbed from 1080i) ~~720p24 (1280~~(1280 horizontal pixels). For video sources that horizontally exceed 720 pixels, the hardware can upscale vertically using replication and downscale vertically using decimation.

Note: This will not be allowed in future versions of this design guide.

?? The ability to upscale and downscale must be implemented in hardware. ~~must be implemented in hardware. Downscaling should be implemented in hardware. Future versions of this design guide are likely to exclude the practice of being able toin the driver.~~

~~Scaling requirements for Entertainment PC systems:~~

~~? The scaling filter (interpolator) is required to implement a minimum of three taps vertically and four taps horizontally.~~

~~Recommended: a minimum of three taps vertically and five taps horizontally be implemented and, ideally, four or five vertical and seven or eight horizontal taps.~~

~~? The ability to shrink or zoom by a variable factor of up to 8:1 in one-pixel increments and the ability to shrink by a variable factor of up to 16:1 in one-pixel increments is required.~~

~~? The image quality should not be perceptible degraded when shrinking by factors up to 4:1. Image degradation is acceptable for the larger shrink ratios, although market acceptance of the product will suffer if image quality is excessively degraded.~~

~~? The scaling engine on a non-DTV–enabled Consumer PC is required to be able to accept a standard input with a rate of 480p60 (720 horizontal pixels) and 720p24 (1280 horizontal pixels).~~

~~-~~The term *tap* is defined here as the number of input pixels that contribute to the building of each output pixel. A bilinear filter is two taps, and a three tap filter is a filter better than bilinear. ~~For filter designs employing three or more taps, it is desirable to use a "windowed sinx/x" function. However, the "windowing" process needs particular attention, especially when small numbers of taps are used to achieve the best subjective picture quality.~~

~~To allow optimization, it is sensible for filter coefficients to be stored in a look-up table with values that are downloadable from the driver. For shrinks greater than a 2:1 ratio, larger numbers of taps are needed or need to be synthesized.~~

~~An example would be putting shrink factors, such as a halving factor in series with the variable shrink factor specified earlier. When doing shrinks, great care needs to be taken with the filter coefficients to minimize spatial aliasing. High-frequency components in the source should ideally be attenuated by either pre-filtering or adjusting the interpolation filter characteristics.~~

~~When s~~Scaling 4:2:2 or 4:2:0 YUV video must achieve~~, scaling is only acceptable with~~ two-pixel granularity.~~ A method must be employed to present this as one-pixel granularity on window size because users will resize windows with one-pixel granularity. One acceptable method would be to crop a one-pixel strip from the resized video where necessary.~~

[New.15.112] If support for TV or DVD video playback is implemented, overlay supports YUY2 and YUV12 color space conversion to RGB

Note to Reviewers: Details will be provided in a future draft.

[New.15.113] If support for TV or DVD video playback is implemented, colorspace conversion can be configured for different color primary standards

Support is required for the 601 color standard. Support is not required for the 709 color standard. These are different conversion equations between the YUV and RGB domains.

14.15 Hardware supports VGA destination color keying for video rectangle

This is a requirement for video overlays. The hardware must be capable of independently controlling the VGA pixels for compositing the video plane under the VGA plane. This VGA destination color keying must function in all video modes using either or both of the following:

?? A specific color/color range, for example, on 4-bit, 8-bit, 15-bit~~, and 24-bit~~ SVGA modes

?? Additional alpha blending bits in the color plane bits on 16-bit and 32-bit SVGA modes

Color keying the VGA allows certain VGA pixels to be replaced by the underlying video pixels on a pixel-by-pixel basis. This feature enables VGA video overlays, controls, Windows pop-up menus, dialog boxes, and so on, and it allows for irregular-shaped graphics compositing. Color keying must work simultaneously with any vertical/horizontal scaling active for the underlying video.

14.16 If support for TV or DVD video playback is implemented, hardware supports alpha blending of graphics and video

Note to Reviewers: Details will be provided in a future draft.

The hardware must support alpha blending for DVD-Subpicture and the user interface (UI) for data-enhanced television.

~~The DVD-Subpicture stream has 4 bits of alpha information per pixel that indicate how the subpicture should be composited with the main picture. In the future, data-enhanced television streams will also require alpha-composited UI functionality with 8-bit control. With 8 bits, the translucency can be faded in and out, which is important to the creative community. Currently, set-top boxes, such as WebTV® service provide this type of control.~~

In color modes that support alpha blending, such as ARGB8888, the blend level is controlled on a per-pixel basis. Color modes that do not support alpha blending, such as RGB 565, must allow an overall constant alpha blend value for the overlay.

A minimum of ~~4~~ 8 bits of alpha blending must be provided in any secondary overlay surface when in 32-bit mode, such as ARGB8888. In other color modes, it is acceptable to synthesize the effect within the secondary overlay surface. ~~This can be done using methods such as screen-door dithering using the overlay color key or 1-bit alpha control.~~ Full 8-bit alpha control is defined as a 256-level linear translucency state from 0 percent (value of 0) to 100 percent (value of 255). When fully implemented, linearity must be monotonic with an accuracy within 0.5 bits.

Whatever alpha-blending scheme is implemented, the driver must present it as an 8-bit control.

14.17 Video port meets PC 2001 specifications if present on graphics adapter

Video side ports are not a preferred video architecture for the future. If a side port is implemented, this requirement applies to all graphics adapters that use a video port connection or that enable end users to make such a connection to a video device. The video port is a dedicated connection between video devices, such as the graphics adapter and an MPEG-2, NTSC, or PAL decoder. A video port can be implemented as a hard-wired connection on the same board as the graphics adapter or implemented between separate devices using a cable connection.

Video side ports that have host port or bi-directional capability can provide a useful way to attach additional functionality to the graphics chip. This can be useful for optional functions and for functions that would not fit on the graphics chip, such as MPEG decoders and high quality de-interlacers.

It is expected that most implementations of graphics adapters will have a single MPEG decoder on the graphics adapter. Providing a side port connector on the card allows addition of other decoders.

For a graphics adapter that includes a video port, the following requirements must be met:

?? **14.17.1 Autoflipping.** The video port must support automated overlay and video port buffer flip on video port vertical synchronization (Vsync).

?? 14.17.2 IRQ. The video port must generate an IRQ when Vsync occurs. The kernel-mode video transport component of DirectDraw version 5.0 and later can use this IRQ to perform autoflips. This capability allows fields to be skipped by the video port and also prevents an irregular synchronization from overwriting its buffers. This also enables capture of vertical blanking interval (VBI) and video port data.

~~*Mobile PC Note*~~ ~~This IRQ is not required for mobile PCs.~~

?? **14.17.3 Driver.** The driver must support DirectDraw Video Port Extension (VPE), which provides a key element of video playback support in DirectX 5.0. This support must be incorporated to ensure that the graphics adapter and video port take advantage of VPE capabilities in the operating system.

For information about implementing DirectX support, see the Windows 2000 DDK. See also the white paper on DirectDraw VPE and kernel-mode video transport at http://www.microsoft.com/hwdev/devdes/vpe.htm.

For additional requirements related to implementing video ports, see “System Requirements for Video and Broadcast Components.”

~~The following guidelines for video ports are to support high-quality TV or DVD video playback:~~

~~**Maximum height.** The graphics adapter should support a register that limits the maximum height of the field that gets written into memory.~~

~~**Separate pitch and start addresses.** The overlay and the video port should support separate pitch and start addresses. This allows the bob algorithm to be used while the video is interleaved, which makes switching between bob and weave modes possible.~~

Note: Video side port bus settings are an exception to the general PC 2001 requirement for dynamic resource configuration. These settings might require jumpers to be moved for some sophisticated configurations. Note also that video side port implementations are generally not a good long term architecture.

Mobile PC Graphics Design

This section defines the specific graphics capabilities for Mobile PC 2001 systems.

These requirements apply only when the mobile system is running on AC power and is not thermally throttled in any way. No display adapter performance requirements apply when the system is running on battery power or in a CPU or bus-throttled mode. It is expected that performance—but not functionality—will be compromised when the mobile unit is operating under battery power or in a throttled mode.

[NEW.120] Mobile system meets Mobile PC 2001 standard graphics requirements if display panel resolution is at least 1024 × 768 and supports at least 24 bpp color depth

A mobile PC that provides an integrated display panel minimum resolution of 1024 × 768 and supports a color depth of at least 24 bpp (actual panel capability) must meet all desktop graphics requirements as defined in this chapter, plus the following guidelines specific to the mobile form-factor and design constraints.

?? **[NEW.120.1]Mobile PC panel guideline.** The built in display panel must provide Active Matrix TFT or better quality. In this context better means both in performance and image quality.

?? **[NEW.120.2] Mobile PC multi-monitor guidelines.** For mobile PCs, multiple adapter support as described in item 14.5 is not required unless the system supports multi-head multi-monitor capabilities or the mobile PC supports a docking station with PCI expansion slots. If the mobile/docking station pair supports only Mini-PCI, the system is not required to support multi-monitor guidelines.

?? **[NEW.120.3] Mobile PC resolution guidelines.** Mobile system resolution and color depth requirements are limited to those of the integrated display panel when the integrated panel is used or when a simultaneous external display is used. Mobile systems that implement a single-chip multi-head configuration must meet the desktop resolution requirements defined in item 14.8—but not color depth for any attached monitor, independent of the integrated panel's capabilities.

?? **[NEW.120.4] Mobile PC guidelines for Plug and Play support for external displays.** The mobile PC must support DDC detection for external displays. These mobile qualifications apply to 14.13, **"**Adapter for external display supports Plug and Play monitor detection." Mobile systems do not have to supply +5V to the VGA connector at any time. The DVI connector must supply +5V only during boot, when the user first enables external video, and when the system is actually outputting analog or digital video through the DVI connector.

?? **[NEW.120.5] Mobile PC refresh frequency guidelines.** Mobile systems must support refresh frequencies only up to the native capabilities of the integrated display panel. A mobile system that implements a single-chip, multi-head configuration must meet the desktop refresh frequency requirements for any attached monitor, independent of the integrated panel's capabilities, as defined in 14.9, "Adapter meets industry specifications for external display interface."

?? **[NEW.120.6] Mobile PC texture size guidelines.** Mobile systems must support square, power-of-two texture sizes of up to 256 × 256, rather than the complete capabilities defined for desktop systems in 14.31, "Hardware complies with texture size limitations."

?? **[NEW.120.7] [was 14.49] BIOS setup utility on Mobile PC provides option to force use of system-board graphics.** The OEM must provide an option in the system BIOS setup utility to force the system-board graphics device to be used as the boot device. Windows will enable any PCI graphics adapter for use in a multi-monitor configuration. This option ensures that a user with a PCI hot-docking system is always able to undock because the VGA device will be in the mobile unit.

See also 16.2, "Monitor supports Integrated Color Management," which applies for mobile PC flat-panel displays.

Note to Reviewers: guideline 6.25 is now redundant and guideline 14.48 has been removed.

[NEW.121] Mobile system meets Mobile PC 2001 basic graphics requirements if display panel resolution is lower than 1024 × 768 or supports less than 24 bpp color depth

A mobile system that supports display resolution lower than 1024 × 768 or a color depth less than 24 bpp (actual panel capability) is required to meet only a minimum set of graphics features and performance requirements. The basic graphics requirements for such mobile PC systems are defined to ensure the ability to boot the required operating systems and reliably run mainstream applications, as defined in the following list:

NOTE: If a mobile system implements any 3D or video features described in this chapter, then it must meet all of the requirements (except resolution, color depth, and panel guidelines) contained in [NEW.120], "Mobile system meets Mobile PC 2001 standard graphics requirements."

?? [120.3] – [120.7] qualifications to mobile design guidelines. Texture size requirements apply if 3_D capabilities are implemented.

?? 14.4 Primary graphics adapter works normally with default VGA mode driver

?? 14.9 Adapter meets industry specifications for External Display Interfaces

?? 14.10 All supported color depths are enumerated

- ?? 14.11 Graphics operations use relocatable registers only
- ?? 14.12 Adapter supports adjustable gamma correction
- ?? 14.13 Adapter for external display supports Plug and Play monitor detection
- ?? 14.20 Extended resources can be dynamically relocated after boot
- ?? 14.21 VGA resources can be disabled by software – this requirement needs to be met by mobile systems only if multi-headed multi-display support exists
- ?? 14.22 Frame buffer can be accessed directly by applications
- ?? 14.23 Adapter and driver support linear-mapped, low-resolution modes
- ?? 14.24 Hardware supports transparent blter
- ?? 14.45 Display devices do not use VGA BIOS POST to populate PCI SSID
- ?? 14.46 System supports conflict resolution, VGA compatibility, and extended registers
- ?? 14.47 Chips support linear packed-pixel frame buffer, relocatable above 16 MB
- ?? 14.48 Option ROM supports DDC2B – for external displays only.
- ?? 14.50 BIOS supports large frame buffers for graphics adapters – for adapters added through docking-station or as PC-card only.
- ?? 14.54 Graphics adapter complies with device class power management reference specification
- ?? 14.55 Graphics adapter complies with VBE/Core 2.0 extensions for power management
- ?? 14.57 Driver does not bypass any Microsoft-provided system components
- ?? 14.58 Applications provided with device meet requirements for Win32-based applications
- ?? 14.59 Driver supports dynamic color depth and resolution changes

Checklist for Graphics Adapters

14.1 Primary graphics adapter uses AGP 2X or another high-speed connection

14.2 Desktop system provides hardware-accelerated 3-D graphics

14.3 System uses WC with higher-performance processors

[New.14.102] If Digital Video interface is implemented, it conforms to DVI specification

14.4 Primary graphics adapter works normally with default VGA mode driver

14.5 Adapter and driver support multiple adapters and multiple monitors

14.6 [DELETE] Adapter supports television output if system does not include large-screen monitor

14.7 [Redundant] Adapter meets PC 2001 general device requirements

14.8 Screen resolution and local memory capacity meet PC 2001 minimum requirements

14.9 Adapter meets industry specifications for External Display Interface

14.10 All supported color depths are enumerated

14.11 Graphics operations use relocatable registers only

14.12 Adapter supports adjustable gamma correction

14.13 Adapter for external display supports Plug and Play monitor detection

14.14 [moved] Hardware supports video overlay surface with scaling

14.15 [moved] Hardware supports VGA destination color keying for video rectangle

14.16 [moved] Hardware supports alpha blending of graphics and video

14.17 [moved] Video port meets specifications if present on graphics adapter

14.18 [DELETE] Hardware supports MPEG-2 motion compensation acceleration

14.19 [DELETE] Hardware supports scanning at the same frequency as the incoming video

14.20 Extended resources can be dynamically relocated after system boot

14.21 VGA resources can be disabled by software

14.22 Frame buffer can be accessed directly by applications

14.23 Adapter and driver support linear-mapped, low-resolution modes

14.24 Hardware supports transparent blter

14.25 Hardware provides support to prevent tearing

14.26 [DELETED]

14.27 Hardware for desktop system supports RGB rasterization

14.28 Hardware for desktop system supports RGB rasterization features

14.29 Hardware supports multi-texturing

14.30 Hardware supports texture formats

14.31 Hardware complies with texture size limitations

14.32 [DELETED]

14.33 Hardware for desktop system supports Z comparison modes and Direct3D-compatible formats

14.34 Hardware for desktop system meets PC 2001 3-D accelerator performance requirements

14.35 [DELETED]

14.36 [DELETED]

14.37 If TV Out is implemented, adapter supports underscan scaling

14.38 If TV Out is implemented, adapter supports flicker filter

14.39 [DELETE]

14.40 If TV Out is implemented, adapter supports composite video connectors

14.41 If TV Out is implemented, adapter with television output supports DVI or VGA and television output

14.42 If TV Out is implemented, software supports positioning

14.43 [DELETED]

14.44 If TV Out is implemented, analog video outputs support copy protection

14.45 Display devices do not use VGA BIOS POST to populate PCI Subsystem ID.

14.46 System supports conflict resolution, VGA compatibility, and extended registers

14.47 Chips support linear packed-pixel frame buffer, relocatable above 16 MB

14.48 Option ROM supports DDC2B

[MOVED]

14.50 BIOS supports large frame buffers for graphics adapters

14.51 AGP meets PC 2001 implementation guidelines

14.52 Graphics device supports IRQ and correctly populates PCI BARs

14.53 System-board graphics device is not hidden from Plug and Play enumeration

14.54 Graphics adapter complies with device class power management reference specification

14.55 Graphics adapter complies with VBE/Core 2.0 extensions for power management

14.56 [Redundant] Device drivers and installation meet PC 2001 requirements

14.57 Driver does not bypass any Microsoft-provided system components

14.58 Applications provided with device meet requirements for Win32-based applications

14.59 Driver supports dynamic color depth and resolution change

14.14 If support for TV or DVD video playback is implemented, hardware supports video overlay surface with scaling

[New.15.112] If support for TV or DVD video playback is implemented, overlay supports YUY2 and YUV12 color space conversion to RGB

[New.15.113] If support for TV or DVD video playback is implemented, colorspace conversion can be configured for different color primary standards

14.15 Hardware supports VGA destination color keying for video rectangle

14.16 If support for TV or DVD video playback is implemented, hardware supports alpha blending of graphics and video

14.17 Video port meets PC 2001 specifications if present on graphics adapter

[NEW10.112] Mobile system meets Mobile PC 2001 standard graphics requirements if display panel resolution is at least 1024 × 768 and supports at least 24 bpp color depth

[NEW.10.113] Mobile system meets Mobile PC 2001 basic graphics requirements if display panel resolution is lower than 1024 × 768 or supports less than 24 bpp color depth

CHAPTER 10B

Video

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter presents the requirements for video and broadcast components, and related adapters.

The key design goal is to ensure that video hardware behave consistently across a wide range of applications, based on the need of the system to provide fast, high-quality rendering.

Video Guidelines

This subsection covers video guidelines, including MPEG-2, DTV, video input and capture, and analog TV.

Note to Reviewers: The sequence of items in the material has changed from PC 99 System Design Guide, and the following items have been

deleted in this new draft because they are either redundant or not relevant for the PC 2001 format. Other deletions are noted in place.

?? 15.1. System meets PC 99 requirements for playback of MPEG-2 video from DVD-Video

?? 15.2. System meets PC 99 requirements for playback of MPEG-2 video from digital TV broadcasts

?? 15.3. System supports PC 99 analog video input and capture capabilities

?? 15.4. System includes analog TV tuner

?? 15.5. System includes digital satellite receiver module

?? 15.6. System includes digital cable receiver module

?? 15.7. System includes ATSC DTV support

?? 15.8. System includes DVB cable, satellite, or terrestrial receiver module

?? 15.9. System includes support for multiple digital TV delivery methods

?? 15.11 MPEG sources such as DVD or a receiver module support bus mastering

?? 15.12 Separate MPEG-2 hardware decoder for high-definition video does not cause PCI bus contention

?? 15.13 PCI-based sources of uncompressed standard-definition digital video support bus mastering with scatter/gather DMA

?? 15.52. Device drivers and installation meet PC 99 requirements

?? 15.53. Software drivers are installed during hardware driver installation

?? 15.54. Applications provided with device meet Win32 requirements

?? 15.55. NDIS 5.0 miniport driver provided for digital broadcast receiver

Baseline Video Features

This section describes basic video features.

A mobile system with a DVD drive and a TFT display is considered a “desktop replacement system,” for which most requirements are similar to those of desktop systems. Differences are called out in “Mobile PC Graphics Guidelines.” Mobile systems without integrated DVD drives or TFT displays do not need to meet any video requirements.

[NEW.15.104] System supports basic video capabilities

For all PC 2001 desktop systems (including workstations), all graphics and video capabilities must be fully supported at 1024 × 768, 32 bpp mode or better.

Mobile PC Note

Mobile PC 2001 systems require support of 640 × 480, 16 bpp mode only.

The following video capabilities are also required for all systems:

?? MPEG—1/2 decompression capability

Mobile systems require MPEG-1 decompression capability only unless system includes a DVD drive in which case MPEG-2 decompression is required.

?? DVI support

15.17 Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

The driver for any video or tuner/decoder device must use the DirectX foundation class to control all video data. The MPEG-2 decoder must support the current DirectShow APIs and must support the WDM Stream class driver architecture. The WDM Stream class must be used to support any data streaming. For information, see the DirectX 5.0 DDK and the Windows 2000 DDK. See also "Device Drivers and Installation for Video and Broadcast Components" later in this chapter.

15.48 All video implementations use DirectShow for video routing and processing

The DirectShow environment must be used for all TV or DVD video implementations. Typical applications include Transport Stream demultiplexing as well as general MPEG stream routing. Drivers must be implemented using WDM.

While it is not a requirement to use the DirectShow filters provided with the operating system, if alternatives filters are used, they must be fully compatible with the filter APIs provided with the operating system. This will help ensure third-party software application compatibility.~~Stream splitting is done on the host CPU using DirectShow filters in the same manner as support is implemented for DVD video input data streams.~~

15.49 [REDUNDANT] Each hardware device has a Plug and Play device ID

Note to Reviewers: This is a general PC 2001 requirement and will not be repeated in separate device chapters

15.50 [REDUNDANT] Dynamic resource configuration is supported for all devices

15.51 Dependent video device is not independently enumerated

If a video device is implemented as a dependent device on a multifunction adapter, it must not be independently enumerated. Instead, its parent must be responsible for installing and loading its driver and for updating the registry on its behalf. See also requirement 3.21, "Multifunction add-on devices meet PC 2001 device requirements for each device."

[New.15.105] If DirectShow filters replace any filters included with the operating system, replacements provide a functional and qualitative superset of the replaced modules

Any replacement DirectShow filter must be able to accept the exact same input and output formats provided by the operating system version of the DirectShow filter.

[New.15.106] All video input devices use WDM drivers

In a PC 2001 system, video input devices must used Windows Driver Model (WDM) device drivers. For implementation guidelines, see the Windows 2000 DDK.

Note to Reviewers: Details will be provided in a future draft.

[New.15.107] All video implementations meet basic video quality requirements

The purpose of this set of requirements is to define how all consumer electronics (CE) high quality TV style video streams must be treated as a whole or by components. The effect should be that the source quality is preserved during playback, storage, or processing of the video streams and overall PC performance is not adversely affected.

The requirements apply to all playback and recording solutions. Excepted are solutions that are serviced by non-isochronous video sources (internet), solutions that utilize inherent quality tradeoffs (conferencing cameras, dongles that convert TV style video into conferencing style video or still video). Also excepted are solutions that provide some video functions for monitoring purposes only and not for recreational viewing such as monitor video windows (outputs) of video editing solutions. CE video guidelines do not apply to mobile systems.

Examples of CE quality video sources are NTSC at 720 × 480 × 29.97 fps and PAL at 720 × 576 × 25 fps, both at 4:2:2, and this is defined as ‘Standard Definition.” Other resolution and frame rate combinations may be subject to the same requirements, depending on the source, but only if the source resolution does not exceed the overall pixel rate of the above example (approximately 10.5 Mpixels/s). Video sources with higher pixel rates may cause system performance to degrade. Either dropped frames or reduced image quality, or a combination of both become acceptable in that case. Combined reduction in image quality and frame rate should be commensurate with the excess in input data rate. For example, if the input data rate exceeds the “Standard Definition” pixel rate by a factor of four then dropping 1/2 of all frames and image quality that is equivalent to having been high-quality scaled by a factor of two horizontally is acceptable.

Notice that de-interlacing results in twice the display data rate when compared to the source data rate. However, de-interlacing by itself must never be the cause for frame rate or image quality reduction. Only increases in source resolution

beyond “Standard Definition” produce a relaxing of the video quality requirements. The requirements include the following:

Note to Reviewers: Details will be provided in a future draft. These items can be expected to be expanded as separate requirements.

?? **[New.15.107.1]** TV-style video source frame and field rates must be preserved to memory and to the display. [15.21.1]

?? **[New.15.107.2]** TV-style video source resolution must be preserved to memory and to the display.

?? **[New.15.107.3]** TV-style video source quality must be preserved to memory and display.

?? **[New.15.107.4]** TV-style video source color information must be preserved to memory and to the display.

?? **[New.15.107.5]** TV-style video source video aspect ratios are preserved and displayed correctly. [15.21.4]

?? **[New.15.107.6]** TV-style MPEG-2 video stream playback consumes less than an average of 45 percent of CPU measured during any given minute.

Mobile PC Note For mobile PCs, 50 percent average is acceptable.

?? **[New.15.107.7]** TV-style MPEG-2 video stream playback consumes less than 45 percent of memory, PCI, or AGP bandwidth during any given minute.

Mobile PC Note For mobile PCs, 50 percent average is acceptable.

?? **[New.15.107.8]** TV-style video stream playback is audio-video synchronized to within 75 ms. Audio-video synchronization drift is corrected without violating the specifics of the frame/field rate requirements. [15.21.2]

~~? **[New.15.107.9]** Baseline video requirements must be maintained for simple playback in any environment with additional workloads of less than 35 percent average CPU, memory, PCI, or AGP utilization during any given minute and with peak utilizations that exceed 35 percent lasting less than 15 ms and not occurring more than once during any given second.~~

~~*Mobile PC Note* Mobile PCs do not have to meet this requirement.~~

Changes to 7.6, 7.7 (35 % to 45 %) and deletion of 7.9 per vbug 183

?? **[New.15.107.10]** Video is made available through input or transform filters in the YUY2 and YV12 4cc color formats while maintaining all other baseline video requirements.

?? **[New.15.107.11]** All video streams that enter the system as “content protected” and can be streamed out to an analog output must be analog copy protected.

?? **[New.15.107.12]** Displayed video that enters the system interlaced but carries a tag identifying how the video fields were derived from a progressive source

will be de-interlaced using the weave method. ~~It is recommended that de-interlacing is performed by the graphics subsystem.~~

?? **[New. 15.107.13]** Displayed video that enters the system interlaced but carries a tag identifying the video source as 24 fps film will be (in combination with weave de-interlacing) played back using a suitable frame rate increasing process such as 3:2 pulldown or better. ~~It is recommended that the graphics subsystem performs the required pull-down or upsampling.~~

?? **[New. 15.107.14]** Displayed video that enters the system interlaced and carries either no identifying tag or is tagged as interlaced material should be de-interlaced by the graphics subsystem using the bob method or a method superior to the bob method. De-interlacing may also take place outside of the graphics subsystem.

?? **[New. 15.107.15]** When video is displayed on a monitor that is refreshed at a different rate than the field/frame rate of the video stream then an optimal frame repeat pattern must be selected.

~~Digital Video Support Guidelines~~

~~This section presents digital video guidelines.~~

~~15.10 System supports DV decoding and encoding~~

~~A digital video compression codec is necessary for displaying video from digital camcorders and for compressing video from other sources. Typically the digital camcorder will supply digital video-encoded (DV-encoded) video to DirectShow. DirectShow includes a software DV codec that can provide the necessary functionality. Although this means that hardware DV decoding is not required, hardware decoding can be used to improve performance or lessen CPU loading. Other video data compression schemes can also be used.~~

MPEG-2 Video Playback Guidelines

This section presents MPEG-2 playback guidelines.

15.14 All MPEG-2 decoders can accept an MPEG-2 elementary stream

DirectShow provides the selection and de-multiplexing of MPEG transport streams and program streams. Stream filtering in hardware can be used to aid this process. DirectShow feeds the appropriate video stream such as ~~Packetized~~ Elementary Stream ~~(PES)~~ to the MPEG decoder. The decoder must be able to take MPEG in that form. PES format support is also required without reliance on any packet sequence numbering ~~is a requirement~~. Nonreliance on packet sequence numbering is necessary to support applications where packet sequence numbers cannot be created, for example, when audio and video come from separate sources, such as video from disc synchronized to audio from the Internet.

Note to Reviewers: We understand that the example "Elementary Stream" is ambiguous. We are working to establish a better spec for the required MPEG dialect into MPEG decoders; this will become a requirement by the 0.7 draft or it will be incorporated into future editions of the PC System Design Guide.

15.15 All MPEG transport stream information is available to the central host processor

MPEG streams can come from a number of sources, including different PCI receivers, Device Bay-based receivers, a set-top box, a set-top computer, a network such as the Internet, or a video-conferencing camera, and so on. DirectShow provides support for selecting the required MPEG streams, de-multiplexing them, and feeding them to the appropriate decoder or subsystem. Stream filtering in hardware can be used to aid this process. Video quality standards must be maintained when streams are being routed via the host processor.

~~Recommended: When possible,~~When Conditional Access systems allow it, the transport stream de-multiplexing ~~is~~ must be performed by the central host processor. In situations where this is not possible, then all streams from the original broadcast must be sent to the processor if the processor requests them.

In the same way that it sends the video to the video decoder, the host software (comprising DirectShow and other components) also sends the audio to the audio decoder and the data services to the appropriate place. This is fundamental to the architecture for digital TV on PCs. On a particular PC, each subsystem could be implemented in software, hardware, or a combination of the two. The operating system needs to be able to manage all the different configurations.

It is not acceptable to implement an “around the side” hardware path from the receiver to the MPEG decoder. The requirement that all digital compressed video streams are routed using the central host software will also make it easier to migrate to video-capable home network environment, where the receiver functions and display functions will typically be in completely separate boxes. It is also fundamental for features such as ~~automatic program recording.~~intelligent TV timeshifting.

15.16 [DELETE] Background tasks do not interfere with MPEG-2 playback

15.17. [MOVED] Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

Note to Reviewers: Appears later in this chapter

15.18 [DELETE] All components meet PC 99 general device requirements

15.19 [DELETE] MPEG-2 MP@ML playback meets PC 99 requirements

15.20 [DELETE] MPEG-2 playback for ATSC, DVB, or other digital TV systems meets requirements

15.21 [DELETE] MPEG-2 video decode implementations meet quality requirements

Note to Reviewers: Some components appear elsewhere in the quality requirements for [New.5] "All video implementations meet basic video quality requirements"

15.22 [DELETE] De-interlacing of standard-definition video meets requirements

15.23 ~~If implemented,~~ MPEG-2 decoder supports the pull-down algorithm

An MPEG-2 software or hardware decoder ~~should~~ must be able to detect and behave accordingly when 3:2 pull down is being used to display 24-fps video. The kernel-mode video transport component in DirectDraw requires this information from the decoder in order to know when a particular redundant field algorithm is being used so it knows which fields to skip.

For more information, see the DirectX DDK.

[NEW.15.114] MPEG decoders with motion compensation or Inverse DCT hardware acceleration use Video Acceleration API

Note to Reviewers: Intel and Microsoft are drafting a video acceleration API to address concerns of the graphics and video chip vendors and software video decoder vendors. This requirement will apply to Motion Comp and Inverse DCT. We anticipate requiring the use of the video acceleration API in the 0.7 version of this design guide.

DVD Video Playback Guidelines

Note to Reviewers: Details will be provided in a future draft.

The following requirements apply for systems that provide DVD-Video playback software and hardware. The goal for DVD and other audio/video (A/V) playback is to ensure that the end-user experience is the same or better than with a stand-alone DVD player.

15.24 If DVD-Video playback is implemented, DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment

Vendor-supplied minidrivers for DVD, MPEG-2, and AC-3 decoders must:

?? Use the correct media types, including validation of all format block fields on connection and on every IPin::QueryAccept message.

?? Query for IMediaSample2 on every received media sample to test for a time discontinuity bit.

It is also acceptable to query on every video/audio frame to reduce CPU overhead.

?? Adjust the decode rate in response to IPin::NewSegment () calls for video and subpicture.

For details about APIs, see the DirectShow documentation in the Microsoft Platform SDK.

15.25 If DVD-Video playback is implemented, DVD decoder supports subpicture compositing and closed captioning

Mobile PC Note For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

The system must be capable of displaying subpicture data as well as providing closed-captioning support for all such data stored on the disc. This requires YUV offscreen overlay surface support as defined in requirement 14.14, "Hardware supports video overlay surface with scaling."

Subpicture streams must be supported as defined in *DVD Specification, Version 1.0,* from Toshiba Corporation.

Note: Alpha blending, or a driver-implemented simulation implemented in the driver, is required for static menus.

15.26 If DVD-Video playback is implemented, subpicture decoder correctly handles subpicture properties and other functions

Mobile PC Note For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

The minidriver for the subpicture decoder must be able to:

?? Set the subpicture properties

?? Turn the subpicture compositing on and off

?? Set the highlight rect parameters

For more information, see the Microsoft DirectX SDK and the DirectX information in the Windows 2000 DDK.

15.27 If DVD-Video playback is implemented, system supports seamless DVD-Video 1.0 navigation

Mobile PC Note

For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

This requirement includes menu navigation, video selection, and language and subpicture track selection in support of the user's ability to navigate DVD-Video discs. ~~Test sources must include, but are not limited to, the following:~~

~~? Matsushita Electronics Incorporated (MEI) test disc~~

~~? Joe Kane Productions Video Essentials disc~~

For any system capable of playing back a DVD-Video title, DVD playback must ~~use~~work with the latest released version of the Microsoft DirectShow Navigator/Splitter filter and other DirectShow test filters to ensure that it conforms to the input and output standards established by the Microsoft Navigator/Splitter. In particular, it must ~~use~~work with the most recent versions of the following:

?? IDvdGraphBuilder

?? Microsoft DirectShow DVD Navigator

?? Microsoft DirectShow Overlay Mixer

The requirement to ~~use~~work with the DirectShow Navigator/Splitter filter is not intended to preclude the use of differentiating product features and enhancements.

[NEW.15.108] DVD-Video player provides seamless and gapless DVD navigation

All DVD-Video players must navigate chapter breaks seamlessly and gaplessly. This requirement holds true even if the underlying elementary streams were created as separate PGC objects. If the navigation calls for a seamless transition, then for any legal GOP structure, bit rate, or both, the player must deliver.

For PC 2001, this player requirement is extended to allow the layer break position to be placed independently, without regard to the type of chapter navigation used. Classically, the layer break is only allowed during non-seamless transitions.

Although not explicitly allowed in the formal DVD-V specification, seamless chapter break transitions span the layer break on some popular DVD features. Therefore, the DVD PC must be able to flawlessly reproducing seamless chapter breaks that are co-located with layer transitions, just as if the layer break weren't there.

Note to Reviewers: Is flawless transition possible? May require pause, etc., similar to DVD consumer players. Can we define "flawless"?

15.28 All DVD video decoders must support Line21 closed-caption data

All DVD video decoders must support Line21 closed-captioned data output compatible for use with the DirectShow Microsoft Line21 decoder filter. In addition to ensuring closed-captioned output for the hearing impaired, it enables applications that use the Line21 channel on DVD as a data channel for non-Line21 data.

15.29 [DELETE] System provides a licensed CSS copyright protection scheme

Video Input and Capture Guidelines

Note to Reviewers: Details will be provided in a future draft.

This section summarizes requirements based on capabilities that support video capture in the Windows 98 and Windows 2000 operating systems. If analog video capture is implemented, the requirements in this section must be met.

15.30 [DELETE] Analog video decoder such as NTSC/PAL/SECAM meets quality requirements

15.31 [DELETE] ~~Analog video capture device outputs video data at 3.7 MB/sec, minimum~~

15.32 If implemented, video input or capture device provides raw sampled VBI data to the host

The ~~raw~~ vertical blanking interval (VBI) data must be ~~decoded in~~made available to the host processor ~~software~~ to provide enhancement data, web pages, and information about elements such as video formats and time code. VBI data must not be affected by any type video operation, such as cropping, scaling, or frame dropping, that the hardware or the driver is performing on the related video frames.

15.33 [DELETE] Digital video camera uses external bus support

15.34 [DELETE] Video input image orientation identification meets requirements

Analog TV Tuner/Decoder and VBI Capture Guidelines

Note to Reviewers: Details will be provided in a future draft.

This section defines requirements for analog TV tuner/decoder capabilities and VBI data capture capabilities in support of the Windows Broadcast Architecture.

15.35 [DELETE] Analog TV tuner/decoder supports PC 99 audio and video performance

15.36 [DELETE] Analog TV tuner/decoder includes stereo audio decoder and supports SAP

15.37 If implemented, VBI capture oversamples VBI data exactly 4.7 or 5 times~~, VBI capture oversamples VBI data at least four times~~

To ensure accurate data reception, data transmitted on all lines of the VBI must be oversampled exactly 4.7 or 5~~at least four~~ times the NABTS data bit rate (or locale-specific data bit rate). For example, if there are 288 bits of NABTS data on a scan line, approximately 1,354~~1,152~~ one-byte samples, plus the necessary margin, must be captured per scan line if 4.7x oversampling is used. This represents the number required for timing tolerances in the NABTS specification and also for timing uncertainties within the capture hardware.

If the hardware cannot provide 4.7 or 5 times oversampled VBI data, the device-specific driver must compensate by resampling, so that 4.7 or 5 times oversampled data are presented to the operating system.

15.38 [DELETE] ~~VBI capture makes VBI data available to the CPU for processing~~

Digital ~~Broadcast~~ TV Receiver Module Guidelines

The requirements in this section apply for any system that implements a digital broadcast subsystem, whether receiving satellite, cable, or terrestrial broadcasts.

It is expected in that the receiver modules will be implemented in the following form factors: Device Bay modules, PCI modules, external modules or set-top boxes using the IEEE 1394. A receiver module that is limited to low bit-rate transmissions, less than 5 Mb/s, could be implemented using standard USB. Device Bay is a good solution for receivers requiring conditional access systems, but conditional access systems can also be implemented with any of the other receiver types.

Digital broadcast and satellite support as defined under these guidelines includes all the requirements for hardware decoder capabilities and driver support as defined in this chapter, plus support for the DirectX foundation class, as defined in the Windows 2000 DDK.

15.39 If implemented, digital broadcast module can receive all streams contained in the particular transport stream

This can be a receiver for cable, satellite, or terrestrial, and other digital TV broadcasts. The receiver module must provide data tuning, demodulation, conditional access, and other network-specific functions.

The receiver module must be able to receive both normal broadcast network-related information, such as MPEG video, audio, and program guide information, as well as data-stream information.

The receiver card must provide a way to allow the host to obtain PCR and other transport stream fields, such as the discontinuity indicator bit, when the card is performing PES packet building. In this mode, the relevant information must be made available by the driver to the host. In addition, the receiver card must provide a mode in which the host can obtain full MPEG-2 transport or program stream headers, and data for selected elementary streams.

15.40 If implemented, digital broadcast module can receive full bandwidth from each frequency

The receiver module must be able to receive all information transmitted on any tuner or transponder frequency. If de-multiplexing is performed on the receiver module, the stream selection and routing must be controlled by software running on the host processor.

15.41 If implemented, digital broadcast module can receive a minimum of ~~16~~ 32 simultaneous elementary streams

The receiver module must be able to simultaneously receive on the same carrier frequency and send to the host either a transport stream or the complete set of elementary streams and accompanying data. Any receiver doing transport stream ~~splitting a~~splitting, for example, a receiver that provides a proprietary conditional access ~~scheme must~~scheme, must support a minimum of ~~sixteen~~32 elementary streams being sent to the host. The streams can be of any type, such as ~~sixteen~~32 simultaneous data streams. These streams, identified by unique service channel IDs (SCIDs) or program IDs (PIDs), are subdivisions of bandwidth on a single tuner frequency.

The receiver module must provide a means for the host processor to control the de-multiplexing of the transport stream (containing the multiple data streams) or pass the complete transport stream to the host processor for software de-multiplexing. The fundamental ~~criterion~~requirement is that the resulting MPEG elementary streams are routed by the software running on the host processor.

~~Recommended: More than 24 simultaneous elementary streams.~~

15.42 [DELETE] ~~System can simultaneously receive two or more broadcast frequencies~~

Note to Reviewers: Recommendations are not included in PC 2001

15.43 If implemented, digital broadcast module provides support for conditional access

Receiver modules ~~should~~ must support conditional access mechanisms for any subscriptions, pay-per-view events, and other network-specific access-control mechanisms available on the broadcast services for which they are designed.

In many cases, this is a removable smart card that has been paired with code and run on a secure processor on the ~~card.~~receiver module. Device Bay provides a convenient way of incorporating a smart card slot, but it is not the only way.

For the separate yet related issue of copy protection, the link from the receiver to the host must be a secure link. It must conform to whatever copy protection ~~scheme is~~requirements are mandated in connection with the terms for the conditional access.

15.44 [DELETE] ~~Digital broadcast module provides signal quality and other diagnostic information~~

Note to Reviewers: Recommendations are not included in PC 2001

15.45 [DELETE] ~~Digital broadcast receiver module supports general-purpose data cryptography~~

Note to Reviewers: Recommendations are not included in PC 2001

15.46 [DELETE] ~~Digital broadcast receiver module supports stream filtering~~g

Note to Reviewers: Recommendations are not included in PC 2001

15.47 If implemented, ATSC DTV tuner/demodulator is fully implemented

If an ATSC DTV tuner/demodulator is implemented, it must meet the requirements for packetized data transport structure, and modulation and transmission systems as specified in *ATSC Digital Television Standard* (A/53), available at http://www.atsc.org.

15.48 [MOVED] Stream splitting is supported using DirectShow filters

Tethered Video Device Support:

Tethered video devices, such as digital video cameras using the USB bus or USB dongles that convert camcorders into virtual digital video cameras are considered low-cost solutions to support video conferencing and low-resolution video authoring. Such devices are exempt of the baseline video requirements. Devices that claim to support “full motion video” or similar quality are not considered

tethered video devices and must meet all baseline video requirements. IEEE 1394 DV-based devices are not considered tethered video devices.

The USB Imaging Class Device Working Group is expected to complete the USB Video Camera Device Definition specification that addresses video camera devices in 1999.

Note to Reviewers: Please comment on how these proposed requirements affect your product roadmap.

[New.15.109] Tethered video devices must support video modes of at least CIF at 15 fps or better

(Resolution frame rates are verified to meet requirement.)

[New.15.110] Tethered video devices must support the YV12 and IYUV FOURccs and formats

Capture driver supports YV12.

[New.15.111] USB camera does not utilize more than 5 Mb/s USB bandwidth at 15 fps CIF

Note to Reviewers: Details to be provided in a future draft.

Mobile PC Video Design

This section defines the specific video capabilities for Mobile PC 2001 systems.

These requirements apply only when the mobile system is running on AC power and is not thermally throttled in any way. No video playback performance requirements apply when the system is running on battery power or in a CPU or bus throttled mode. It is expected that performance—but not functionality—will be compromised when the mobile unit is operating under battery power or in a throttled mode.

[NEW.121] Mobile system meets Mobile PC 2001 standard video requirements if display panel resolution is 1024 × 768 × 24 bpp or higher

A mobile PC that provides an integrated display panel minimum resolution of 1024 × 768 and supports a color depth of at least 24 bpp must meet all desktop video requirements as defined in this chapter, plus the following guidelines specific to the mobile form-factor and design constraints.

?? TV-style MPEG-2 video stream playback consumes less than an average of 50 percent of CPU measured during any given minute.

?? There is no bus bandwidth restriction for consumption of memory, PCI, or AGP bandwidth in TV-style MPEG-2 video stream playback.

[NEW.122] Mobile system meets Mobile PC 2001 basic video requirements if display panel resolution is lower than 1024 × 768 or supports less than a 24 bpp color depth

A mobile system that supports display resolution lower than 1024 × 768 or a color depth less than 24 bpp is not required to support video related features. The basic video requirements for such mobile PC systems are defined in the following list:

?? Comply with 14.57, “Driver does not bypass any Microsoft-provided system components,” and 14.58, “Applications provided with device meet requirements for Win32-based applications.”

?? Support all related desktop video requirements if the mobile system implements support for optional video capabilities, with the following basic mobile video guidelines:

  ?? There is no CPU utilization limitation and no bus bandwidth restrictions for MPEG-2 playback.

  ?? Systems with DSTN displays must preserve source frame rates during video playback only to the extent the display is capable of refreshing.

Checklist for Video

[NEW.15.104] System supports basic video capabilities

15.17 Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

15.48 All video implementations use DirectShow for video routing and processing

15.49 [REDUNDANT] Each hardware device has a Plug and Play device ID

15.50 [REDUNDANT] Dynamic resource configuration is supported for all devices

15.51 Dependent video device is not independently enumerated

[New.15.105] If DirectShow filters replace any filters included with the operating system, replacements provide a functional and qualitative superset of the replaced modules

[New.15.106] All video input devices use WDM drivers

[New.15.107] All video implementations meet basic video quality requirements

15.14 All MPEG-2 decoders can accept an MPEG-2 elementary stream

15.15 All MPEG transport stream information is available to the central host processor

15.16 [DELETE] Background tasks do not interfere with MPEG-2 playback

15.17. [MOVED] Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

15.18 [DELETE] All components meet PC 99 general device requirements

15.19 [DELETE] MPEG-2 MP@ML playback meets PC 99 requirements

15.20 [DELETE] MPEG-2 playback for ATSC, DVB, or other digital TV systems meets requirements

15.21 [DELETE] MPEG-2 video decode implementations meet quality requirements

15.22 [DELETE] De-interlacing of standard-definition video meets requirements

15.23 MPEG-2 decoder supports the pull-down algorithm

15.24 If DVD-Video playback is implemented, DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment

15.25 If DVD-Video playback is implemented, DVD decoder supports subpicture compositing and closed captioning

15.26 If DVD-Video playback is implemented, subpicture decoder correctly handles subpicture properties and other functions

15.27 If DVD-Video playback is implemented, system supports seamless DVD-Video 1.0 navigation

[NEW.15.108] DVD-Video player provides seamless and gapless DVD navigation

15.28 All DVD video decoders must support Line21 closed-caption data

15.29 [DELETE] System provides a licensed CSS copyright protection scheme

15.30 [DELETE] Analog video decoder such as NTSC/PAL/SECAM meets quality requirements

15.31 [DELETE]

15.32 If implemented, video input or capture device provides raw sampled VBI data to the host

15.33 [DELETE] Digital video camera uses external bus support

15.34 [DELETE] Video input image orientation identification meets requirements

15.35 [DELETE] Analog TV tuner/decoder supports PC 99 audio and video performance

15.36 [DELETE] Analog TV tuner/decoder includes stereo audio decoder and supports SAP

15.37 If implemented, VBI capture oversamples VBI data exactly 4.7 or 5 times

15.38 [DELETE]

15.39 If implemented, digital broadcast module can receive all streams contained in the particular transport stream

15.40 If implemented, digital broadcast module can receive full bandwidth from each frequency

15.41 If implemented, digital broadcast module can receive a minimum of 32 simultaneous elementary streams

15.42 [DELETE]

15.43 If implemented, digital broadcast module provides support for conditional access

15.44 [DELETE]

15.45 [DELETE]

15.46 [DELETE] g

15.47 If implemented, ATSC DTV tuner/demodulator is fully implemented

15.48 [MOVED] Stream splitting is supported using DirectShow filters

[New.15.109] Tethered video devices must support video modes of at least CIF at 15 fps or better

[New.15.110] Tethered video devices must support the YV12 and IYUV FOURccs and formats

[New.15.111] USB camera does not utilize more than 5 Mb/s USB bandwidth at 15 fps CIF

[NEW.10.110] Mobile system meets Mobile PC 2001 standard video requirements if display panel resolution is 1024 × 768 × 24 bpp or higher

[NEW10.111] Mobile system meets Mobile PC 2001 basic video requirements if display panel resolution is lower than 1024 × 768 or supports less than a 24 bpp color depth

CHAPTER 11

Monitors

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

~~The digital revolution is finally extended to the display device.~~ The Digital Visual Interface (DVI) specification provided by the Digital Display Working Group is the industry standard that allows ~~displays~~ designers to ~~confidentially~~ implement the digital interface with confidence.~~-~~ The large legacy of analog VGA monitors can still be fully supported by systems ~~compliant~~ that meet the guidelines presented in this system design guide. ~~In an effort to comprehend the dawning of the digital age of monitors, t~~This ~~section~~ chapter is divided into th~~r~~es~~e~~ ~~sub~~sections:

?? "Monitor Basic Features," presenting design guidelines that are ~~Requirements~~ common for all monitors types.

?? "Large Format Monitor Requirements," defining guidelines for monitors larger than 25 inches.

?? "Digital Monitor Features," featuring specific guidelines for ~~Requirements specific to~~ digital monitors.

?? "Analog Monitor Features," featuring ~~Requirements~~ specific guidelines for ~~to~~ analog monitors.

Monitor Basic Features

This section summarizes the basic design requirements common to all monitor types.

Note: Dot-pitch requirements are not specified in these guidelines because dot pitch depends on resolution and size. Also, design features other than dot pitch contribute to usability for PC applications, such as focus and phosphor. Monitors should be designed to provide a sharp and clear image across the full range of resolutions they are intended to support.

[16.1] Color monitor is DDC2B-compliant with unique EDID identifier

A monitor designed for or included with a PC 2001 system must be compliant with Display Data Channel Standard, Version 3.0, Level 2B protocols (DDC2B), which defines the communications channel between the display and host system**. A monitor must assume multiple I2C compliant devices exist on the communications bus, and as such, a monitor must not impede the use of the I2C bus in any way.** A monitor designed for, or included with, a PC 2001 system ~~is not allowed~~must not issue DDC1 transactions.

The monitor also must transmit an Extended Display Identification Data (EDID) structure containing unique ID Manufacturer Name and ID Product Code identifiers, plus all required fields, as defined in Section 3 of *Extended Display Identification Data Standard, Version 3.0* or later.~~ The monitor must transmit a EDID 1.3 compliant data structure.~~

Mobile PC Note

Mobile systems are not required to support DDC monitor detection of the display if the display is permanently attached and connected using an internal interface. However, such systems must support DDC for the external monitor interface port.

[NEW.11.101] Monitor supports EDID 1.3 data structure

Note to Reviewers: This explanatory text for this guideline will be provided in the 0.7 draft. EDID 1.3 support is a key element to enable Microsoft ClearType? display technology stand-alone LCD displays.

[NEW.11.102] LCD display meets ClearType display technology requirements

Note to Reviewers: This explanatory text for this guideline will be provided in the 0.7 draft. This guideline will apply to both external LCD monitors and integrated LCD displays. Integrated LCD displays will be required to provide EDID 1.3 equivalent data via registry entries or ACPI control methods. Specifics are forthcoming in the 0.7 draft.

[16.2] Monitor supports Integrated Color Management

Systems running Windows 98 and Windows 2000 operating systems must use color profiles that comply with the International Color Consortium (ICC) Profile Format specification. The Integrated Color Management (ICM) APIs and functionality for Windows 98 and Windows 2000 are described in the Microsoft Platform SDK and the Windows 2000 DDK.

Mobile PC Note

Color-capable devices such as desktop CRT monitors, LCDs on mobile systems, color plasma and other flat-panel devices, printers, scanners, or still-image cameras are required to install one or more ICC profiles for ICC color management. A monitor color-calibration utility ~~is recommended~~can be used for generating, editing, and installing ICC profiles. The standard RGB (sRGB) profile will be distributed in Windows 98 and Windows 2000.

ICC profiles are not required for notebook computers with DSTN panels.

[16.3] Monitor meets all PC 2001 general device and driver requirements

See requirement 3.16, "Device driver and installation meet PC 2001 requirements."

~~This includes the basic requirements for Plug and Play device IDs, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors. For more information, see "PC 2001 General Device Requirements" in Chapter [X], "PC 2001 Basic Requirements."~~

~~The manufacturer does not need to supply a driver if a PC 2001-compliant driver provided with the operating system can be used. If the manufacturer supplies a driver, it must comply with requirement X.X, "Device driver and installation meet PC 2001 requirements." The requirements include driver support for unattended installation and Help file support if special driver parameters are used.~~

Note: Monitor support for Windows is installed using a monitor INF file, as defined in the Windows 98 DDK and Windows 2000 DDK.

~~**[16.4] [DELETE] CRT-based monitor supports a mechanism for control from host software**~~

Note to Reviewers: Recommendations are not included in PC 2001.

[16.5] Monitor meets minimum graphics resolution, based on monitor size

With the following higher resolutions, a larger desktop area can be displayed, more applications can be shown on the display at once, individual windows can be larger, applications can be fully displayed side by side, and so on:

?? 14-inch to 15-inch external monitor or built-in mobile PC display = 800 × 600, non-interlaced

?? 17-inch external monitor or 13-inch to 15-inch external LCD = 1024 × 768, non-interlaced

?? 19-inch and larger monitors or external LCDs larger than 15 inches = 1280 × 1024, non-interlaced

Note: These specific monitor sizes are not ~~listed as recommended or~~ required; they ~~merely~~ show the required ~~resolution~~ pixel format for a given size monitor.

[16.7] CRT-based monitor synchronizes to a new format in ~~a timely fashion~~less than three seconds

When the scanning rate into the monitor is changed from one of its valid rates to another valid rate, the monitor must resynchronize to the new format and produce a stable picture within three seconds from the graphics adapter becoming stable.

This capability is important because sometimes a change from a high refresh-rate graphics mode to a 60-Hz (or 59.94 variant) mode is necessary to optimize video playback.

~~**Note:** The monitor should be designed to minimize the noise emitted as it transitions between rates because this noise can be alarming to some users.~~

[16.10~~NEW.16.101~~] Monitor supports Text Mode 3, 640x480 and 640 × 400

During system boot and in the event of an error, Windows 98 and Windows 2000 use lower resolution scanning formats such as 640 × 480, 640 × 400, and “text mode 3.” ~~The monitor must be able to display these important screens. It can be confirmed that a monitor that complies with this requirement by booting a PC and ensuring that the monitor is able to sync to all the screens displayed during the boot sequence.~~

[16.12] External monitor meets DDC2B and EDID standards

This requirement is based on DDC2B, which defines the communications channel between the display and host system, and on EDID Version 3.0, which defines

data formats for configuration information. This requirement includes the identification string and other EDID data that the monitor sends to the system.

Use the established standard or (if necessary) detailed timings to indicate the maximum resolution that the monitor ~~will support.~~supports. Using either the established or the standard timings ~~will result~~results in greater flexibility when using detailed timing descriptor blocks.

The following items are particularly critical:

?? EDID content must indicate the complete range of the monitor's capabilities.

   Do not use the EDID to indicate only the preset modes that the monitor supports. Take advantage of the established and standard timings to include as much information about the monitor's capabilities as possible.

?? At least one piece of information must indicate the maximum resolution plus maximum timing at that resolution supported by the monitor. If this indication is not implemented using the established or standards timings,~~then~~ a detailed timing can be used.

To enhance the Plug and Play functionality of monitors, the following monitor descriptor definitions are ~~strongly recommended~~required, as defined in the VESA EDID standard:

?? **FD (monitor range).** This information is essential for enabling the operating system to calculate the optimal refresh rate for any selected resolution.

?? **FC (monitor name).** Up to three detailed timing blocks can be used to incorporate the company and model name. These descriptors ~~will~~must be concatenated for a single string, and the blocks must be used in the order in which they are to be concatenated.

?? **FF (monitor serial number).** If provided, this information ~~will be~~is placed in~~to~~ the registry for easy access by asset-management software.

Large Format Monitor Requirements

Large format ~~monitor are defined as monitor~~monitors are larger than 25 inches, measured diagonally. These monitors typically require a picture tube ideal for both PC graphics and television/movie video. This section defines the requirements for large format entertainment monitors. The large format monitors are required to meet all requirements common to all monitors.

[16.9] Large Format CRT-based monitor supports 800 × 600 at 60 Hz refresh rate

R~~ecommended r~~efresh rate for North America is: 60 Hz (and 59.94 variant) ~~for North America~~. Various rates are appropriate for Europe, such as 50, 60, or 75 Hz, depending on the video processing capabilities of the host PC.

~~It is acceptable to use~~In North America, using 60 Hz (or the 59.94 variant) ~~In North America~~is acceptable because these types of monitor are intended to be viewed from at least a 6-foot distance, thus avoiding excessive flicker. Keeping the rate the same as the native video source ~~will result~~results in the best video quality because of the judder problems associated with using linear video processing to change refresh rates.

A display format of 800 × 600 at 60 Hz progressive (or the wide-screen equivalent) requires a refresh rate of about 38 kHz. This rate is commonly available in CRT-based large-screen TV-style monitors. A display format of 1024 × 768 at 60 Hz progressive (or the wide-screen equivalent) is preferable, but requires a scan rate of around 47 kHz. With the advent of good scaling ~~on graphics adapters~~ and program-enhancing additional data services, good use can be made of the higher resolution if it is available.

~~This requirement does not mean to imply the large format monitor needs to use CRT technology. The use of~~ Large-format flat-panel ~~alternatives is encouraged. The~~ monitors must meet the same resolution and size~~, but not timing,~~ requirements ~~are the same~~ as for CRT devices, but are not required to meet the same timing requirement.

[16.11] If implemented, large format monitor implements host control~~large Format monitor's host control has digitally controlled geometry~~

If implemented, the mechanism for software control of monitor functionality must comply with either the Universal Serial Bus specification version 1.1, or the VESA DDC/CI standard version 1.0. Host software controls brightness, contrast, screen offset, and so on.

Other controls, such as picture offset, are important since the system needs to switch between desktop refresh rates, such as 75 Hz, and video refresh rates, such as 60 Hz, to optimize video playback. Software control is also important in remote control applications such as IR/RF remote.

Geometry control is necessary for adjustment of PC television images and includes the following controls: skew, pin cushion, size, brightness, contrast, and position. Geometry control must be provided through a software application rather than through dials on the monitor case. Controls must be revealed through a driver with a remote-controllable user interface.

Digital Monitor Features

This section summarizes the specific requirements for Digital monitors.

[NEW.16.102] Digital display interface is DVI compliant

The DVI interface is the industry standard interface for digital display device interconnect interface. Any system implementing digital monitor output

capabilities must implement a DVI-compliant port. Any monitor or display device accepting digital input for display data must implement a DVI-compliant port.

[NEW.16.103] Digital monitor enters a sub-1 watt power state when +5V signal transitions to zero

A digital monitor must enter a sub-1 watt power state when the +5V signal in the DVI connector transitions to zero.

The DVI specification enables monitors to be aggressively power managed. The transition of the +5V signal associated with DDC in the DVI connector indicates to the monitor either that the system has been turned off or that the system will not use the monitor for an extended period of time. In either case, the monitor must enter an extremely low power state.

[NEW.16.104] Digital monitor supports Hot Plug Detection

A digital monitor must provide a +5V signal to the system within 250mS of the system's assertion of the +5V DDC signal to indicate that the monitor is present and capable of transmitting EDID data. A digital monitor must provide the +5V Hot Plug Detection Signal to the system as long as the system is providing the +5V DDC signal to the monitor.

Analog Monitor Features

This section summarizes the specific requirements for Analog monitors.

[16.6] CRT-based monitor supports ergonomic timing standards

The monitor must, at a minimum, support the timings documented in *VESA and Industry Standards and Guidelines for Computer Display Monitor Timing Version 1.0, Revision 0.7* or later, for all resolutions supported by the monitor, as based on monitor size, as cited earlier in this section. The standards ensure a clear, flicker-free display for traditional PC computing.

~~It is~~ Also~~a requirement that~~ monitors ~~are~~must be able to operate with the 59.94 variant of the 60-Hz VESA timing. All references to 60-Hz timing in this chapter ~~should be taken to also indicate~~also include the 59.94 variant.

[16.13] Analog ~~M~~monitor complies with device class power management reference specification

The Display Device Class Power Management Reference Specification, Version 1.0 (http://www.microsoft.com/hwdev/specs/PMref/PMdisplay.htm) or later, provides definitions of the OnNow device power states (D0–D3) for graphics adapters and monitors. The specification also covers device functionality expected in each power state and the possible wake-up event definitions for the class, if any. CRT monitors must support the D0, D2, and D3 power states. The D1 power state is optional for monitors.

~~*Digital Monitor Note*~~

~~Digital displays for mobile and desktop applications can implement just two power states: on and off.~~

Note to Reviewers: Digital power management is addressed in "Digital Monitor Features."

Checklist for Monitors

[16.1] Color monitor is DDC2B-compliant with unique EDID identifier
[NEW.11.101] Monitor supports EDID 1.3 data structure
[NEW.11.102] LCD display meets ClearType display technology requirements
[16.2] Monitor supports Integrated Color Management
[16.3] Monitor meets all PC 2001 general device and driver requirements

[16.5] Monitor meets minimum graphics resolution, based on monitor size
[16.7] CRT-based monitor synchronizes to a new format in less than three seconds
[16.10] Monitor supports Text Mode 3, 640x480 and 640 × 400
[16.12] External monitor meets DDC2B and EDID standards
[16.9] Large Format CRT-based monitor supports 800 × 600 at 60 Hz refresh rate
[16.11] If implemented, large format monitor implements host control
[NEW.16.102] Digital display interface is DVI compliant
[NEW.16.103] Digital monitor enters a sub-1 watt power state when +5V signal transitions to zero
[NEW.16.104] Digital monitor supports Hot Plug Detection
[16.6] CRT-based monitor supports ergonomic timing standards
[16.13] Analog monitor complies with device class power management reference specification

CHAPTER 12

Audio

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Basic Audio Requirements

This section defines basic hardware feature requirements for audio components. These are system-based requirements, targeted for the entire PC solution as it ships, regardless of whether the audio components are separate add-on devices or are built into the system, for example, on the system board or the display monitor.

This section summarizes the system requirements for audio.

~~[17.1] [DELETE] PC1. system includes PC 2001 audio capabilities~~

[17.2] [REDUNDANT] Audio device does not connect to ISA bus

Note to Reviewers: "No ISA" is a basic PC 2001 requirement

[17.3] Audio device does not use legacy hardware interfaces for MS-DOS–based applications

If the audio device supports MS-DOS–based applications, it must use operating system-provided or operating system-compatible software emulation of legacy interfaces when the application is running. Legacy hardware does not meet PC 2001 requirements if the legacy technique allows MS-DOS–based applications to communicate directly with ISA IRQ, DMA, or I/O hardware resources, such as PC/PCI or DDMA.

When running MS-DOS–based applications in a virtual MS-DOS box, the level of legacy compatibility provided by Windows 98 software emulation is comparable to hardware. ~~Support for legacy hardware techniques in real-mode MS-DOS, Windows 3.1, or Windows 95 is acceptable, as long as it does not interfere with Windows 98 operation.~~

This requirement also applies to PCI-based audio devices. Whether Windows-based or MS-DOS–based applications are running, the PCI device must not allocate or use ISA IRQs, DMAs, or hard-coded I/O locations. The BIOS and Windows driver must not contain any options to select the use of ISA resources for the audio device.

If a device supports real-mode operation, the only acceptable manner for acquiring ISA resources is to use a real-mode configuration utility.

Audio Performance and Feature Requirements

This section summarizes the performance requirements for audio on PC 2001 systems.

Several companies joined together to develop *Personal Computer Audio Quality Measurement* (PCAQM), a standard testing procedure for defining and measuring audio performance. Contributors to PCAQM include Audio Precision, Compaq Computer Corporation, Crystal Semiconductor, Intel Corporation, and Microsoft Corporation. PCAQM definitions and test methods are available from the web site at http://www.cirrus.com/products/papers/meas/meas.html.

[17.4] Audio ~~performance~~ meets PC 2001 requirements

The following table summarizes audio performance requirements for all audio-enabled PC 2001 systems, with the exceptions noted for mobile audio. These requirements establish a minimum performance level for PCs; system designers

are encouraged to exceed these minimum requirements~~, especially for Consumer PCs~~.

~~*Mobile PC Note*~~

~~Most specifications and tests isolate half-duplex play or record performance. Additional attention should be paid to full-duplex systems with an embedded microphone and speakers, such as mobile PCs and multimedia monitors, where acoustic coupling can significantly degrade microphone performance.~~

For precise definitions of the terminology used in the following table, please refer to the PCAQM test methodology paper cited earlier in this section.

PC 2001 Audio Minimum Performance Requirements

Feature	Requirement	Value
Full-scale input voltage	FSIP (A-D-PC) line input	? 2.0 Vrms
	FSIP (A-D-PC) microphone input	? 100 mVrms
Full-scale output voltage	FSOP (PC-D-A) line output	? 1.0 Vrms[1]
Analog pass-through (A-A)	Line input to line output	
	Frequency response (-3 dB)	20 Hz to 20.0 kHz[4]
	Dynamic range (~~SNR~~DR)	? 80 dB FS A[4]
	THD+N (-3 dB FS)	? –65 dB FS[4]
	Microphone input to line output	
	Frequency response (-3 dB)	100 Hz to 12.0 kHz
	Dynamic range (~~SNR~~DR)	? 70 dB FS A[4]
	THD+N (-3 dB FS)	? –60 dB FS[4]
	Line input to speaker output with 8-ohm load[2]	
	Frequency response (-3 dB)	~~20~~ 100 Hz to 20.0 kHz[4]
	Dynamic range (~~SNR~~DR)	? 70 dB FS A[4]
	THD+N (-3 dB FS)	? –55 dB FS[4]
Digital playback (PC-D-A) for line output	Frequency response (-3 dB)	
	44.1 kHz source material	20 Hz to 17.6 kHz[4]
	48.0 kHz source material	20 Hz to 19.2 kHz[4]
	Passband ripple	<+/-0.5 dB
	Dynamic range (~~SNR~~DR)	? 80 dB FS A[3, 4]
	THD+N (-3 dB FS)	? –65 dB FS[4]
Digital playback (PC-D-A) for speaker output	Speaker output with 8-ohm load[5]	
	Frequency response (-3 dB)	
	44.1 kHz source material	100 Hz to 17.6 kHz[4]
	48.0 kHz source material	100 Hz to 19.2 kHz[4]
	Dynamic range (DR)	? 80 dB FS A[3, 4]
	THD+N (-3 dB FS)	? –65 dB FS~~[4]~~FS[4]
Digital recording (A-D-PC) for line input	Frequency response	
	44.1 kHz destination	20 Hz to 17.6 kHz[4]
	48.0 kHz destination	20 Hz to 19.2 kHz[4]

	Passband ripple	<+/-0.5 dB
	Dynamic range (~~SNR~~DR)	?70 dB FS A[4]
	THD+N (-3 dB FS)	?–60 dB FS[4] (input-referenced)
Digital recording (A-D-PC) for microphone input	Frequency response (-3 dB) 22.05 kHz destination	 100 Hz to 8.8 kHz
	Passband ripple	<+/-0.5 dB
	Dynamic range (~~SNR~~DR)	?70 dB FS A[4]
	THD+N (-3 dB FS)	?–60 dB FS[4] (input-referenced)
Line output cross-talk	Channel separation between left and right line out channels (measured at 10 kHz)	?60 dB[4]
Sampling frequency accuracy	Playback	0.1%
	Record	0.1%

[1] For mobile PCs with 3.3 V audio subsystems, the required Full Scale Output Voltage for line output is ?0.7 Vrms.

[2] Line input to speaker output is a requirement only if a line output is not supported.

[3] Decibels relative to full scale (FS), measured using "A weighting" filters.

[4] For mobile PC~~s: The dynamic range requirements are relaxed by 10 dB FS A. The THD+N requirements are relaxed by 10 dB FS. The required frequency response is 20 Hz to 15 kHz, measured using 3 dB corners. The cross-talk requirements are relaxed by 10 dB FS.~~, see 'Requirements for Mobile PC Audio' for exceptions and differences.

[5] Where separate line and speaker out puts are provided.

To meet output performance requirements stated in the table above, audio subsystems that provide output conditioning to enhance speaker performance must provide separate speaker and line outputs, or must provide means to disable output conditioning.

[17.5] Audio subsystem supports basic data formats ~~in full duplex~~

Windows 98 and Windows 2000 provide software mixing and sample rate conversion (SRC), which eliminate the need for hardware to support all possible rates. Therefore, the hardware is required to support only two key rates: 44.1 and 48kHz:

?? 44.1kHz is required for efficiency reasons. Most game content uses a sampling rate that is an integer divisor of 44.1 kHz. In addition, CD audio is 44.1kHz. When the highest input stream is 44.1kHz and below, the optimal way to operate the audio output is to convert everything to 44.1kHz and run the audio device at this rate. This conversion provides the best quality and least CPU overhead.

?? 48kHz is required because it is the prevalent sampling rate for entertainment content; the audio content for DVD movies is a good example. When 48kHz content is present, the operating system switches the audio output to 48kHz.

~~To meet output performance requirements of section 17.4, audio subsystems that provide output conditioning to enhance speaker performance must provide separate speaker and line outputs, or must provide means to disable output conditioning.~~

[17.6] Audio subsystem supports full duplex operation ~~at independent sampling rates~~

Full duplex audio is essential to support emerging communications applications such as IP telephony, conferencing, and network gaming. These applications require the audio system to play back and record simultaneously. The following requirements ensure that full duplex operation is available and performance is consistent across implementations.

?? **[17.6.1] Full duplex operation is supported for all sampling rates supported by the hardware.** If the built-in or external audio device includes both input and output capabilities, full duplex operation must be supported for basic formats (16-bit, 44.1 and 48 kHz), and for all other formats (for example, at 8, 11.025, 16, 22.05, and/or 32 kHz) supported by the hardware.

?? **[17.6.2] Sample rates are time-synchronized.** If the built-in or external audio device includes both input and output capabilities, the timing relationship between input and output sample rates must remain constant. For instance, if 8 kHz is selected for both input and output sampling rate, audio hardware must ensure that the sampling rate for input and output is precisely matched. Further, when input and output sample rates are set to integer ratios, the actual sample rate ratios must match. For instance, if 8 kHz input sampling rate and 32 kHz output sampling rate are selected, the ratio of actual sampling rates must be precisely 8:32.

This can be accomplished by ensuring that both input and output sampling rates are derived from the same clock, and that sample rate divisors are set correctly.

If the built-in or external audio device includes both input and output capabilities, audio device must support independent selection of input and output sample rates. ~~Voice recognition and audio/video conferencing require the audio system to simultaneously play back and record. Incoming and outgoing audio should be capable of operating at independent sampling rates. This requirement considers the entire system, including the possibility of USB speakers or microphones.~~

[17.8] Audio driver reports sample position for stream synchronization

The driver must be capable of reporting within 1 ms the current position of the buffer being rendered, in relation to the samples given to the codec. This requirement applies for both compressed and uncompressed data.

For information about WDM device driver support for streaming capabilities, see the Windows 2000 DDK. See also the related articles available on the web at http://www.microsoft.com/hwdev/desinit/csa1.htm.

For information about WDM device driver support for streaming capabilities, see the “Kernel Streaming Drivers Design Guide” in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win2k/ks-overview_4svn.htm).

[17.9] [REDUNDANT] Audio connectors use icons with standard color coding

Note to Reviewers: This is a basic PC 2001 requirement

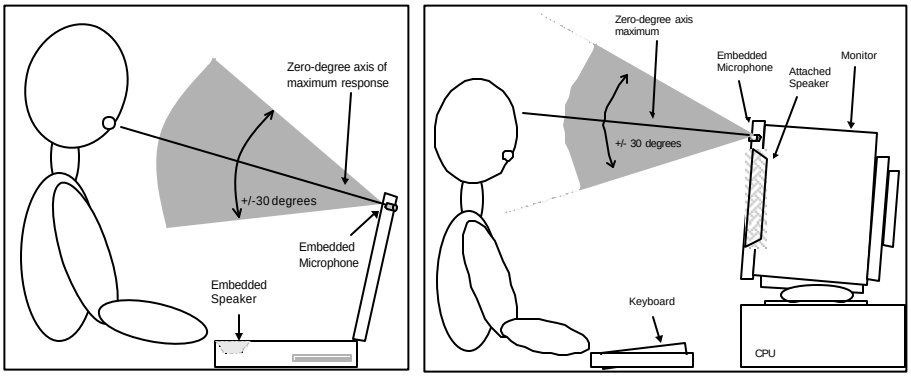
~~**17.10 [DELETE] Audio subsystem provides sufficient externally accessible inputs and outputs**~~

Note to Reviewers: Recommendations are not included in PC 2001.

~~**17.11 [MOVED] Microphone meets performance recommendations for PC 99 speech recognition microphones**~~

[NEW.17.101] Embedded transducers must meet PC 2001 requirements for directivity and orientation.

Where implemented, an embedded microphone subsystem must have a directivity index (DI) of at least 3.0dB over all operating frequencies. The microphone subsystem’s zero-degree axis of maximum response must lie within +/-30 degrees of users mouth position during normal system use. Microphone gain at this distance must remain within 1dB of maximum gain throughout the +/- 30-degree range. To minimize acoustic coupling, embedded speakers must be positioned so as to have a maximum gain of 0 dB in relation to the gain at the user’s mouth position, during normal use.



Note to Reviewers: See "Requirements for Voice Input" later in this chapter.

[NEW.17.102] If implemented, audio system provides 2-D and 3-D hardware acceleration according to PC 2001 requirements

If the audio hardware provides acceleration for DirectSound or DirectSound3D, it must declare its capabilities as follows.

?? The device must accurately report the maximum number of 2-D and 3-D buffers it can play simultaneously. For example, if the device declares that it can support 20 2-D buffers and 30 3D buffers, it must be able to play 20 2-D buffers or 30 3-D buffers simultaneously. Ideally, the device could play all 50 buffers simultaneously.

?? The device must accurately report the number of available 2-D and 3-D buffers. The device must be able to open and play another 2-D or 3-D buffer when the reported number of available voices is greater than 0.

?? The device is required to render all of the declared buffers using less than 10% of the baseline CPU, as specified in PC2001. This measurement applies to all of the software and hardware the device uses to render buffers, with the exception of the standard operating system components.

Note to Reviewers: Please provide input on what is a meaningful limit for consuming host resources, or if such a limit is necessary.

[17.12] If implemented, audio system provides DLS acceleration according to PC 2001 requirements~~Audio subsystem provides hardware or software support for DLS~~

If the audio system provides hardware acceleration of DLS (Downloadable Sounds) using DirectMusic, it must adhere to the following requirements:

?? The audio system must be able to fulfill all of the capabilities it declares. For example, if the DirectMusic device indicates that it can play 64 voices and provide reverb, it is required to do all of the above, simultaneously.

?? The audio system must not consume more than 10% of the baseline CPU while performing all of the functions it offers to the system. This measurement applies to all of the software and hardware the device uses to render buffers, with the exception of the standard operating system components.

Note to Reviewers: Please provide input on what is a meaningful limit for consuming host resources, or if such a limit is necessary.

Requirements for Voice Input

This section discusses incremental requirements for audio subsystem and peripheral devices to support applications requiring voice input on the PC. Applications include IP telephony, conferencing, and speech recognition.

These requirements ensure microphone input compatibility for voice-input enabled applications such as speech recognition, speakerphone telephony, and conferencing.

[17.7] If implemented, analog microphone input meets PC 2001 jack and circuit requirements

~~This requirement provides a more detailed specification for the analog characteristics of the microphone input jack.~~

This requirement enables users with electret or dynamic microphones to connect the device to their PC and achieve consistent results. These requirements also maintain compatibility with the installed base of microphones. For information about optional close-speaking headset microphones, see requirement 17.11, "Microphone meets performance recommendations for PC 2001 speech-recognition microphones."

If the PC has an analog microphone input, it must meet the following specifications:

- Three-conductor 1/8-inch (3.5 mm) tip/ring/sleeve microphone jack where the mic signal is on the tip, bias is on the ring, and the sleeve is grounded. This design is optimized for electret microphones with three-conductor plugs, but will also support dynamic microphones with two-conductor (ring and sleeve shorted together) plugs.
- Minimum AC input impedance between tip and ground: minimum, 4 kOhm; recommended, 10 kOhm.
- Input voltages of 10–100 mV deliver full-scale digital input, using software-programmable ?20-dB gain for low output microphones.
- Maximum 5.5 V with no load, minimum 2.0 V with 0.8 mA load, DC bias for electret microphones.
- Minimum bias impedance between bias voltage source and ring: 2 kOhm.
- AC coupled tip.

Note: These requirements are designed to ensure that audio captured via microphone input meets performance requirements called out in section [17.4].

[17.11] If implemented, close-speaking headset microphone meets performance requirements for PC 2001 speech-recognition microphones

The following requirements are for close-speaking headset microphones intended for use in speech-recognition applications.

Note to Reviewers: These guidelines represent a consensus on optimal characteristics for close speaking headset electret microphone used for speech recognition. They should enable developers of speech recognition software to provide the OEM or retail customer with a list of devices designed to work optimally with a PC 2001-compliant microphone input jack.

These requirements are compatible with most of the installed base of sound cards and audio-enabled system boards. See section 17.7 for detailed microphone jack requirements.

The requirements for a PC 2001 speech-recognition microphone are:

?? Close-speaking headset design positions microphone within 1.5 inches of the corner of the speaker's mouth

?? Full scale output voltage: 100 mV (0 dB FS)

?? Microphone connector meets requirements stated in section 17.7.

?? Operating bias voltage from 2.0–5.0 Volts Direct Current (VDC) with a maximum current drain of 0.8 mA

?? Capable of sustaining a maximum voltage of 10 VDC on tip or ring without damage

?? Frequency response:

?? ?~~5~~ 3 dB from 100 Hz to 10kHz

?? 0 dB at 1 kHz

?? Minimum sensitivity of –44 dB relative to 1V/Pa

?? Maximum 2% Total Harmonic Distortion (THD+N) 100 Hz~~hZ~~ to 10kHz at 94 dBSPL

?? Noise cancellation null sensitivity at 90 and 270 degrees +/- 10 degrees with the following minimums:

20 dB at 100 Hz	20 dB at 4000 Hz
20 dB at 400 Hz	10 dB at 10 kHz
20 dB at 1000 Hz	

?? Maximum wind noise sensitivity of –65 dB with 0 dB = 1 V (measured with wind speed of 1m/s at the 0 degree axis of microphone)

?? Maximum output impedance of 1 kOhm (using a 1 kHz full-scale test tone with 2.0 VDC bias)

Close-speaking (pressure gradient) headset microphones detect the pressure difference between the microphone sound ports. This pressure difference results from dispersion of sound pressure as the utterance exits a user's mouth; test instruments such as the Brüel & Kjær (B&K) 4227 can simulate this dispersion pattern. When the distance from the aperture to the test microphone is specified, and a constant sound pressure is maintained at the test microphone location, near field sensitivity and frequency response of the headset microphone can be accurately measured. The test distance is 6mm from the top surface of the Mouth Simulator, along the centerline of the aperture.

In practice, it is not possible for the reference microphone and test microphone to occupy the same physical location. Since the microphone location is critical to the realized pressure differential at this close distance, the sound pressure is correlated at this location (using a free field reference microphone) to the sound pressure of a pressure reference microphone installed in the B&K 4227. This correlation allows the sound field compressed with the installed microphone to be corrected to the sound field at the test position, and allows the correct near field frequency response for the headset microphone to be measured.

[17.13] Audio subsystem supports AEC reference inputs

Built-in or external audio devices that include both input and output capability and introduce additional digital or analog audio sources into the final mix (that is, mixing, music synthesis, and so on) must support simultaneous capture of microphone and acoustic echo cancellation (AEC) reference inputs.

At minimum, audio hardware must enable mono mix of final output and microphone input (post microphone gain) to be routed through the line input, with microphone input routed to in left channel and mono mixed output in right channel. This routing can be achieved using existing line-in A/D converters.

Alternatively, audio hardware may implement an independent microphone input channel with associated A/D conversion, and enable stereo mix of final output to be routed through line input, or through entirely independent input channel. ~~The reference should be time-synchronized and available at the same sample rate as the microphone input.~~

For more information, see Section 6.2 of *Audio Codec '97 Component Specification* from Intel Corporation, which describes one possible implementation. This specification is available at http://developer.intel.com/pc-supp/platform/ac97/.

Requirements for Multi-Channel Audio

This section addresses requirements to support multi-channel audio, whether discreet or encoded.

[17.15.] Video playback-enabled system meets PC 2001 audio performance requirements for video, CD, DVD, and broadcast audio playback

These requirements ensure quality playback of MPEG-2 audio from any source, including DVD, digital broadcast or satellite systems, hard drives, and so on. The goal for DVD and other audio/video playback is to ensure that the end-user experience is the same or better than from a stand-alone DVD player.

For those PCs that support software or hardware decoding and playback of DVD-Video or MPEG-2 video, the audio decoder must be capable of supporting one or both of the following formats is required, depending upon the local requirements for DVD audio:

?? AC-3 (Dolby Digital) less than or equal to 5.1 channels, at 48 kHz less than or equal to 448 Kbps

?? MPEG-2 multi-channel less than or equal to 5.1 channels, at 48 kHz less than or equal to 912 Kbps

?? MPEG-1 Layer 2 stereo, at 44.1 and 48 kHz less than or equal to 448 Kbps

?? LPCM less than or equal to 8 channels, 16-bit, 20-bit, and 24-bit at 48 or 96 kHz less than or equal to 6.144 Mb/s

Note: Conversion to 44.1-kHz or 48-kHz 16-bit stereo is acceptable when the content exceeds the available resolution, sampling rates, or number of output channels.

[NEW.17.103] Where implemented, S/P-DIF meets relevant S/P-DIF specifications

Where system implements S/P-DIF input and/or output, implementation must be fully compliant with current IEC-958, or EIAJ CP-340, as appropriate.

[NEW.17.104] Where implemented, S/P-DIF output provides write-through capability

Where audio subsystem implements S/P-DIF output, audio subsystem must provide a mode of operation that allows previously encoded data to be passed through the S/P-DIF connector without alteration of the encoded binary data.

Note to Reviewers: Please provide clarifying language to ensure requirements are correctly represented.

Requirements for Digital Audio

This section discusses requirements for audio devices implemented for USB and 1394.

[17.17] [REDUNDANT] Audio subsystem does not provide a DB-15 analog joystick/MIDI port

Note to Reviewers: "No legacy and proprietary devices" is a basic PC 2001 requirement

[17.18] [REDUNDANT] Each hardware device has a unique Plug and Play device ID

Note to Reviewers: This is a basic PC 2001 requirement and will not be repeated in each device chapter

[17.19] ~~[~~REDUNDANT~~]~~ ~~D~~ynamic resource configuration is supported for all devices

Note to Reviewers: This is a basic PC 2001 requirement and will not be repeated in each device chapter

[17.20] [REDUNDANT] PCI device conforms to PCI 2.2 and additional PC 2001 requirements

Note to Reviewers: This is a basic PC 2001 requirement

[17.21] PCI device supports initiator, target, and block transfer

For complete implementation details, see PCI 2.2.

Full-duplex audio sample transport must be supported using separate PCI bus mastering hardware for playback and capture sample streams.

~~It is desirable for Sample transport mastering hardware should support burst capabilities in order to read or write multiple samples within the same PCI bus transaction. This support lessens the impact of sample transport on other agents in the system, which has a positive effect on the system's responsiveness.~~

[17.22] PCI device supports efficient audio buffer management~~non-DWORD aligned audio buffers~~

The audio device must not consume more than two percent of the CPU transferring audio data. This maximum is two percent for all streams, not per stream. This measurement applies to all of the software and hardware the device uses strictly for the transfer of the audio data, with the exception of the standard operating system components.

The audio device must be able to fully function when the system can only provide single pages of contiguous memory. In other words, the audio device can require many pages of memory, but must not require the largest block of contiguous memory to exceed one page. This requirement ensures audio support in docking and dynamic loading scenarios where memory may be completely fragmented page-wise.

The audio device and associated device-specific driver must not introduce more than 1ms additional latency. In this context, latency is defined as the time

between the render or capture of audio signals, and the corresponding transfer of data between the device-specific driver and the WDM audio stack.

[17.23] [MOVED] PCI device does not use ISA-based resources

Note to Reviewers: Requirement 17.23 was subsumed into 17.3

[17.24] PCI device is digital ready

To transfer digital audio to USB or IEEE 1394 devices, all digital audio data created in the PC must be available to the operating system for mixing and streaming. All PCI audio devices must be able to route the final mix of all digital audio data created or processed on-chip to the host using bus master transfers.

For example, a PCI audio device provides HRTF 3-D filtering and wave-table synthesis. After mixing all of the separate 3-D sources and wave-table channels down to a single stereo stream, the device transfers the data to host memory.

PC 2001 requires all output channels to be available to the host for redirection. If the device supports more than two output channels, for example, four or six, all output channels must be redirectable to the host.

[17.25] USB audio meets USB specification and USB audio device class specification

If USB audio is implemented, the device must comply with *Universal Serial Bus Specification, Version. 1.0* or later, and with *USB Device Class Definition for Audio Devices, Version 0.9* or later. This requirement ensures that all Plug and Play requirements are met and that drivers provided with the operating system support this device.

[17.26] USB audio device that implements volume or pan control uses MMHID ~~for control of basic functions~~

If the USB audio device implements a volume or pan control, it must use the Multimedia Human Interface Device (MMHID) protocol to communicate these changes to and from the host.

[17.27] IEEE 1394 audio meets PC 2001 requirements for IEEE 1394

IEEE 1394 audio peripherals must meet the requirements defined in Chapter 8, "IEEE 1394."

Power Management for Audio

This section summarizes the power management requirements for audio components.

[17.28] [REDUNDANT] System and device comply with PCI bus power management specification

Note to Reviewers: This is a basic PC 2001 requirement for PCI devices

[17.29] Audio device complies with device class power management reference specification

Audio devices must comply with *Audio Device Class Power Management Reference Specification, Version 1.0* or later, which provides definitions of the OnNow device power states (D0–D3) for these devices. The specification also covers the device functionality expected in each power state and the possible wake-up event definitions for the class. The device and driver are required to implement support for power states D0, D2, and D3. Other power states are optional.

Audio devices implemented on the system board must comply fully with the ACPI 1.0b specification (or later).

Device Drivers and Installation for Audio

This section summarizes requirements for audio device drivers.

[17.30] [REDUNDANT] Device drivers and installation meet PC 2001 requirements

Note to Reviewers: This is a basic PC 2001 requirement for all devices

[17.31 Audio meets PC 2001 requirements for WDM driver support

All audio devices must have drivers that use the WDM architecture exclusively. Audio devices must not use VxDs. The manufacturer can either supply a WDM driver with the audio device or rely on a WDM driver provided with Windows 98 and Windows 2000. For information, see the Windows 2000 DDK.

[17.32] Applications provided with device meet Win32 requirements

Any Windows-based applications provided with the device must meet software compatibility requirements as defined in the Microsoft Platform SDK.

Requirements for Mobile PC Audio

This section covers audio for the Mobile PC.

[6.12] Audio-enabled Mobile PC meets Mobile PC 2001 audio performance requirements

Audio must meet the requirements for PC 2001 audio as defined in earlier sections of this chapter, with exceptions as defined in this section. These

exceptions for Mobile PC systems arise from design challenges such as lower power and smaller form factors.

For Mobile PCs, the following exception and difference are defined for audio requirement [17.4], “Audio performance meets PC 2001 requirements.” For Mobile PCs that implement a 3.3 V audio codec in order to decrease system power, the required Full Scale Output Voltage (FSOP) for line output is ?0.7 Vrms

Notice that frequency response is measured at line out.

The PC 2001 design requirements allow for the audio controller to be implemented on the mobile unit with output capabilities implemented on a docking station. For related audio requirements for the mobile PC/docking station pair, see the “Docking Station Requirements” section later in Chapter 15, “Mobile Computing.”

~~? Dynamic range requirements are relaxed by 10 dB FS A~~

~~? THD+N requirements are relaxed by 10 dB FS~~

~~? Required frequency response is 20 Hz to 15 kHz, measured using 3 dB corners~~

~~? Cross-talk requirements are relaxed by 10 dB FS~~

Note to Reviewers: Specific changes to advance mobile audio capabilities will be identified in subsequent revisions of this document.

[6.37] Audio-enabled docking station/mobile pair meets PC 2001 audio performance requirements

If audio is implemented, the docking station/mobile PC pair must meet the requirements for PC 2001 audio as defined in Chapter 17, “Audio Components,” with additional requirements as follows:

?? The user must not be required to select speakers in the mobile unit or the docking station upon docking.

?? The docking station is not required to implement full desktop audio capabilities, but it can supplement the audio capabilities of the mobile unit.

Checklist for Audio

[17.2] [REDUNDANT] Audio device does not connect to ISA bus

[17.3] Audio device does not use legacy hardware interfaces for MS-DOS–based applications

[17.4] Audio meets PC 2001 requirements

[17.5] Audio subsystem supports basic data formats

[17.6] Audio subsystem supports full duplex operation

[17.8] Audio driver reports sample position for stream synchronization

[17.9] [REDUNDANT] Audio connectors use icons with standard color coding

[NEW.17.101] Embedded transducers must meet PC 2001 requirements for directivity and orientation.

[NEW.17.102] If implemented, audio system provides 2-D and 3-D hardware acceleration according to PC 2001 requirements

[17.12] If implemented, audio system provides DLS acceleration according to PC 2001 requirements

[17.7] If implemented, analog microphone input meets PC 2001 jack and circuit requirements

[17.11] If implemented, close-speaking headset microphone meets performance requirements for PC 2001 speech-recognition microphones

[17.13] Audio subsystem supports AEC reference inputs

[17.15.] Video playback-enabled system meets PC 2001 audio performance requirements for video, CD, DVD, and broadcast audio playback

[NEW.17.103] Where implemented, S/P-DIF meets relevant S/P-DIF specifications

[NEW.17.104] Where implemented, S/P-DIF output provides write-through capability

[17.17] [REDUNDANT] Audio subsystem does not provide a DB-15 analog joystick/MIDI port

[17.18] [REDUNDANT] Each hardware device has a unique Plug and Play device ID

[17.19] [REDUNDANT] Dynamic resource configuration is supported for all devices

[17.20] [REDUNDANT] PCI device conforms to PCI 2.2 and additional PC 2001 requirements

[17.21] PCI device supports initiator, target, and block transfer

[17.22] PCI device supports efficient audio buffer management

[17.23] [MOVED] PCI device does not use ISA-based resources

[17.24] PCI device is digital ready

[17.25] USB audio meets USB specification and USB audio device class specification

[17.26] USB audio device that implements volume or pan control uses MMHID

[17.27] IEEE 1394 audio meets PC 2001 requirements for IEEE 1394

[17.28] [REDUNDANT] System and device comply with PCI bus power management specification

[17.29] Audio device complies with device class power management reference specification

[17.30] [REDUNDANT] Device drivers and installation meet PC 2001 requirements

[17.31 Audio meets PC 2001 requirements for WDM driver support

[17.32] Applications provided with device meet Win32 requirements

[6.12] Audio-enabled Mobile PC meets Mobile PC 2001 audio performance requirements

[6.37] Audio-enabled docking station/mobile pair meets PC 2001 audio performance requirements

C H A P T E R 1 3

Storage

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Storage Basic Guidelines

This section presents the requirements for storage and related peripherals, including DVD devices. For related acoustical requirements for storage devices, see requirement [3.7], "Audible noise meets PC 2001 requirements."

For specific information about implementation details related to storage devices under the Windows 98 and Windows 2000 operating systems, see the articles at http://www.microsoft.com/hwdev/storage/.

[18.1] Storage components and optical devices support bus master capabilities

NOTE: Bus master support is required of optical device in this timeframe in order to adequately support video playing for DVD and CD-ROMs.

Hard disk and optical devices (such as CD and DVD devices) must support bus mastering, and bus mastering must be enabled on the host by default. When correctly implemented, bus master support ensures improved performance and Windows-compatible device driver support.

Bus master capabilities must meet the related specification for the particular controller. For example, the programming register set for PCI IDE bus master DMA is defined in the *ATA/ATAPI-~~4~~ 5* or later standard.

A DVD drive and controller must support byte-aligned, multisegment, bus master DMA transfers. DMA must be enabled by default.

If attached by way of an ATA interface, ATAPI DVD drives and ATA system-board implementations must support DMA as specified in the ATA/ATAPI-~~4~~ 5 standard or SFF 8090.

Note: This requirement does not apply to legacy floppy disk controllers (FDCs) and will not become a requirement for legacy FDCs.

[18.2] Removable media devices support media status notification

The following list shows the required specifications for implementing media status notification, depending on device type.

Device type	Media status notification implementation
CD and DVD devices	Comply with A*NSI NCITS T10 Multi-Media Command Set-2 (MMC-2)* standard for Media Status Event Notification.
ATAPI floppy/optical direct access drives	Comply with either MMC-2 standard or SFF 8070i Version 1.1.
IEEE 1394 storage devices	Comply with *NCITS Reduced Block Commands* (RBC; T10/97-260r0) standard.
ATA and non-ATAPI storage devices	Comply with *Media Status Notification Support, Version 1.03*.
Other ATA/ATAPI devices, including tape drives	If implemented, comply with *Media Status Notification Support Specification, Version 1.03*, or SFF 8070i.
Other types of SCSI removable devices	If implemented, support based on *NCITS Reduced Block Commands* standard.

[18.5] Device Bay storage device complies with Device Bay 1.0 and other specifications

All Device Bay controllers and devices included with a PC 2001 system or provided as retail devices must meet the requirements defined in *Device Bay Interface Specification, Version 1.0.* Any storage device designed as a Device Bay peripheral must also interface with USB, IEEE 1394, or both. If it interfaces with USB, the device must support the *Universal Serial Bus Device Class Definition for Mass Storage Devices, Version 1.0*9 or later.

[18.6] ATA devices support Ultra DMA

All ATA primary storage devices must support Ultra DMA at transfer rates of 33 MB per second or higher as defined in the ATA/ATAPI-~~4~~ 5 standard, and as described in requirement [10.7], "Controller supports Ultra DMA."

~~A peripheral that does not support the Ultra DMA transfer protocol must, at a minimum, implement the termination scheme required by this protocol in order to be tolerant of Ultra DMA.~~

Note to Reviewers: Guideline 18.10 has been removed for OEM industry discussion. It is intended that IEEE-1394 will propagate as the external storage connection for high-speed devices in the future. It is recognized that OEMs currently have selection of two or more interfaces for secondary or external storage, so there can be no firm requirement in this area.

Hard Disk Drives

This section summarizes specific requirements for hard disk drives. The device must also meet the general requirements defined in "Storage Controller and Peripherals Basic Features" and "PC 2001 Design for Storage Components" in this chapter.

Note: BIOS support is required for LBA for all read and write operations to ATA disk drives that have capacities greater than 528 MB. For more information, see requirement [10.5], "System BIOS and devices support LBA."

[18.15] If implemented, SMART-compliant hard drive meets data-handling requirements

If implemented, the drive must meet the requirements for data handling as defined in the *SMART IOCTL API Specification, Version 1.1.* The Self-Monitoring, Analysis, and Reporting Technology system (SMART) is an industry term used to describe technology that monitors and predicts device performance. ~~If implemented, it must meet the requirements for data handling as defined in the*SMART IOCTL API Specification, Version 1.1* or later, published by Compaq~~

~~Computer Corporation and Microsoft Corporation, describes the API used by an application to issue SMART commands to a hard drive under the Microsoft Windows family of operating systems. If SMART compliance is implemented, the driver must support the SMART IOCTLs.~~

CD Devices

This section summarizes the requirements for CD peripherals. The device must also meet the general requirements defined in "Storage Controllers and Peripherals Basic Features" and "PC 2001 Design for Storage Components" in this chapter, including requirement [18.1], "Storage controller and devices support bus master capabilities."

[18.16] CD device provides 8x minimum transfer rate or better performance

This requirement sets the minimum speed needed for production level CD reading on Windows platforms. This requirement applies to the minimum read speed (8x) on any production level CD media, such as application or game software, at any location on the disc. This minimum speed requirement does not apply to end user recorded CD data discs, or discs being read in error-correcting, defect management mode. OEMs should continue to ship CD drives that produce an acceptable user experience and conform to the specifications cited in section 18.18.

[18.17] CD drive is CD-enhanced compatible

The CD drive must be able to mount multisession CD-ROM discs, even if track 1 is Red Book audio.CD-Enhanced support must be Blue Book compliant, as defined in *Enhanced Music CD Specification, Version 1.0*.

[18.18] CD drive supports specified logical and physical CD formats

At a minimum, the CD drive must be compatible with the following formats to ensure cross-media compatibility, based on compliance with the *Optical Storage Technology Association (OSTA) MultiRead Specification for CD-ROM, CD-R, CD-R/RW, and DVD-ROM Devices, Version 1.11*:

?? Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), Orange Book parts II and III (packet writing if recordable), White Book, Blue Book, and UDF versions 1.5 and 2.0.

?? Physical formats: ROM (stamped), and Orange Book part II (CD-R) and part III (CD-RW).

Note: Any ATAPI CD drive designed to play back CD-I content must return a minimum of two track entries for the READ_TOC (0x43) command. These two track entries must be a track 01 entry and a track 0xAA entry for the lead-out address. Drives that do not comply with this minimum requirement cannot play back CD-I movies.

[18.19] ATA/ATAPI CD drive complies with MMC-2

CD drives attached to the system using the ATA interface must support the hardware and protocols documented in ~~*ATA Packet Interface for CD-ROMs, SFF-8020i, Version 2.6 or later*~~*ANSI NCITS T10 Multi-Media Command Set-2 (MMC-2)*.

Note: Support for the READ CD-DA command as defined in the MMC-2 standard is required.

[18.20] CD drive supports multisession and compatibility forms of the READ_TOC command

Both multisession forms (01b and 10b) and the compatibility form (00b) of the READ_TOC command must be implemented. This ensures complete support for CD-ROM multisession capabilities.

For information about ATAPI peripheral support for CD-I content, see requirement [18.18], "CD drive supports specified logical and physical CD formats."

[18.21] ATA/ATAPI CD changer complies with the MMC-2 standard

If an ATAPI-compatible CD changer with a capacity for seven or fewer discs is present, the changer must comply with the MMC-2 standard.

[18.22] CD device supports digital audio detection

CD drives must support the bit "CD Capabilities and Mechanical Status Page" (2Ah), as defined in the MMC-2 standard. The bit "CD-DA Commands Supported" must be set if the drive can provide digital audio streams. This bit must be unset if the drive is not capable of digital audio.

The bit "CD-DA Stream is Accurate" of "CD Capabilities and Mechanical Status Page" can be set only if either the READ_CD command or READ_RAW command provides sector-accurate reads, as defined in MMC-2. Data alignment accuracy must be equivalent to that of data reads. Because of the lack of ECC bytes used for data tracks, the data itself might contain inaccuracies due to physical defects of the media. This bit must be unset if the conditions are not met.

[18.23] CD and DVD devices use push-to-close design

Except for mobile implementations, the device must be designed so the user has three options for closing the device when inserting a disc:

?? Physically pushing on the bay

?? Physically pushing the close button on the bay housing

?? Selecting a software-supported option to close the device

Rewriteable Optical ATAPI Devices

This section summarizes specific requirements for rewriteable optical storage devices. The device must also meet the general requirements defined in "Storage Controller and Peripherals Basic Features" and "PC 2001 Design for Storage Components" in this chapter.

[18.24] Block rewritable optical ATAPI device complies with SFF 8070i v1.1 or later

SFF 8070i defines the requirements for block rewriteable ATAPI devices, including specifications for logical unit number (LUN) implementation, media status notification, and device write protection. This document also includes required support for the Read Format Capacities command.

DVD Devices

This section summarizes specific requirements for DVD devices. The device also must meet the general requirements defined in "Storage Controller and Peripherals Basic Features" and "PC 2001 Design for Storage Components" in this chapter.

For information about the requirements for DVD-Video and MPEG-2 playback performance, see Chapter [X], "Video and Broadcast Components." For more information about DVD support under Windows 98 and Windows 2000 operating systems, see the articles at http://www.microsoft.com/hwdev/devdes/dvdwp.htm.

[NEW.18.102] DVD drive reads all DVD formats

Note to Reviewers: The following is being considered as a requirement for PC2001. We would appreciate your feedback.

In PC 2001, all DVD drives must be able to read all DVD formats, including:

DVD-ROM	DVD-RW	CD-R
DVD-R	DVD+RW	CD-RW
DVD-RAM	CD-ROM	All CD book formats

[18.25] DVD device provides 2x minimum transfer rate or better performance anywhere on the disc

The minimum sustained DVD device media transfer rate must be at least 2 MB per second for read operations from the DVD disc.

This requirement sets the minimum speed needed for DVD-Video playback during MPEG2 decoding on Windows platforms. This requirement applies to the minimum read speed (2 MB/s) on any production level DVD-Video media, at any location on the disc. This minimum rate requirement does not apply to end user recorded DVD data discs, or discs being read in error-correcting, defect

management mode. OEMs should continue to ship DVD drives that produce an acceptable user experience and conform to the specifications cited in section 18.27.

[18.26] [REDUNDANT] DVD drive and controller support bus master DMA transfers

Note to Reviewers: See item 18.1

[18.27] DVD drive meets minimum compatibility requirements

DVD drives must support all the functionality of CD drives as outlined in "CD Devices" earlier in this chapter.

~~Specifically, the DVD device must be compatible with the following formats to ensure that the DVD device can read earlier media:~~

~~? Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), White Book, Orange Book parts II and III (packet writing), Blue Book, UDF versions 1.5 and 2.0, and DVD video if applicable.~~

~~? Physical formats: ROM (stamped), Orange Book part II (CD-R) and part III (CD-RW), and ECMA-267 and ECMA-268 (DVD-ROM).~~

~~Recommended: Support for ECMA-274 (PC+RW) and ECMA-272, 273 (DVD-RAM 1.0 and DVD-R).~~

~~Conforming to *OSTA MultiRead Specification, Version 1.11* indicates compliance with all of these compatibility requirements.~~

[18.28] DVD ~~device~~ drive complies with the MMC-2 standard

A DVD device must comply with the MMC-2 standard, which defines the implementation requirements that the Windows 98 or Windows 2000 operating systems support. The drive must support the following commands:

Beh	Read CD	08h	Device reset
B9h	Read CD MSF	A0h	Packet
4Bh	Pause/resume	A1h	Identify packet device
E5h	Check power mode	Efh	Set features
90h	Execute device diagnostic	E6h	Sleep
E1h	Idle Immediately	E0h	Standby immediate
00h	NOP		

DVD devices must also support the following:

?? Timeout model as designed and documented in MMC-2.

?? Get Event Status command (Media Event Status class) and all related commands, including Persistent Prevent/Allow, as defined in MMC-2.

?? Get Configuration command for Morphing class devices (Class 2), as defined in MMC-2. Windows 98 uses the Get Configuration command to determine whether media event status is supported correctly.

[18.30] DVD ~~device~~drive supports defect management

DVD drives must support defect management that is transparent to the operating system, according to industry standards. Defect management for DVD-RAM media is defined in *DVD Specifications for Rewritable Disc, Part 1: Physical Specifications*, published by Toshiba Corporation. Defect management for DVD+RW is defined in ECMA-274.

[18.31] DVD ~~device~~drive supports copyright protection

Note to reviewers. This does not imply that you will have to license a third-party implementation.

The drive must support a licensed implementation of the CSS copyright-protection scheme and support CSS-protected discs to ensure proper protection for prerecorded video content, as defined in the DVD specification.

Software is provided as part of the Windows 98 and Windows 2000 operating system support for DVD in order to facilitate the authentication process required by this scheme. This support allows a DVD drive to authenticate and transfer keys with a CSS content decrypter. Windows 98 and Windows 2000 operating system software acts as the agent to allow either hardware or software decrypters to be authenticated.

Note: As noted in the disclaimer for *PC 2001 System Design Guide*, Intel and Microsoft do not make any warranty of any kind that any item developed based on this design guide, or any portion of this design guide or related specification, will not infringe any copyright, patent, trade secret, or other intellectual property right of any person or entity in any country. It is your responsibility to seek licenses for such intellectual property rights where appropriate. Intel and Microsoft shall not be liable for any damages arising out of or in connection with the use of these specifications, including liability for lost profit, business interruption, or any other damages whatsoever.

PC 2001 Design for Storage Components

This section summarizes requirements related to Plug and Play and other resource-related design issues for storage devices.

[18.37] Device and controller comply with Storage Device Class Power Management Reference Specification

The *Storage Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–

D3) for these devices. The specification also covers device functionality expected in each power state and possible wake-up event definitions for the class. Support is required for power states D0, D1, and D3 for hard disks, CD and DVD drives, and other mass storage devices. Support for the D1 state is not required for floppy disk devices.

Mobile PC Note

~~For mobile hard drives, it is recommended that a Read operation typically be completed within 5 seconds of applying power or leaving the D1 state and transitioning to D3. For desktop systems, the recommendation is 10 seconds.~~

~~The drive spin-up time recommendation is not expected to become a requirement in future versions of this guide.~~

If implemented, the ability to cause a wake-up event must be as defined in the *Storage Device Class Power Management Reference Specification, Version 1.0* or later.

Device Drivers and Installation for Storage

This section summarizes the basic requirements for device drivers and installation procedures for storage devices.

[18.39] [REDUNDANT] Device drivers and installation meet PC 2001 requirements

Note to Reviewers: This basic PC 2001 requirement is no longer repeated in every chapter.

[18.40] Device driver runs in protected mode following installation

The device driver must be running in 32-bit protected mode, not compatibility mode, immediately following installation.

Note: Although it is preferred that a system reboot not be required as part of device installation, it is recognized that installation of boot devices presents a special situation. It is acceptable that installation of a boot device includes restarting the system.

[18.41] Applications provided with the device meet Win32 requirements

Any Windows-based applications provided with the device must meet requirements for software compatibility, as defined in the Microsoft Platform SDK. However, any software applications included with the device can be installed using an alternate Windows-based installation method, as defined in the Microsoft Platform SDK.

[18.42] Device driver for partitioned media supports all Windows 98 and Windows 2000 partition types

Device drivers that support partitioned media must support all Windows 98 and Windows 2000 partition types, which include but are not limited to FAT16, FAT32, and NTFS, plus UDF 1.5 and 2.0 for CD and DVD.

[18.43] Device driver for block-mode device supports extended BPBs

Storage subsystems that include an MS-DOS–based block-mode device driver, for example, Aspidisk.sys, must support Extended BIOS Parameter Blocks (BPBs) in the Build BPB device driver function call, and must support category=48 in the generic IOCTL device driver interface calls, as specified in the latest update to the Windows 2000 DDK.

SCSI Storage

This section presents guidelines for SCSI storage. The use of SCSI in a PC 2001 system is optional.

[11.5] [REDUNDANT] Connector complies with bus standards and bus type is clearly indicated on connector

[11.6] Differential devices support DIFFSENS as defined in SPI standard

Without DIFFSENS, the differential bus drivers, a single-ended device, or both could be damaged if a single-ended device is connected to a differential bus. The standard for DIFFSENS is defined in Section 5.4.2 of the SPI standard.

Note to Reviewers: This reference will be corrected in coming draft versions.

[11.10] Controller and peripherals implement SCSI bus data protection signal

The SCSI host adapter and all SCSI peripherals must implement the SCSI bus data protection signal defined in the SPI standard, and data protection must be enabled by default. This signal was formerly referred to as the parity signal.

[11.12] External devices use automatic termination or an accessible termination switch

An external SCSI peripheral device must provide automatic termination. At a minimum, a mechanical means must be provided for setting termination and the switch must be accessible to the user without opening the device chassis.

[11.22] Devices supports the STOP/START UNIT command as defined in the SPI-3 or later standard

SCSI peripherals must be able to fully recoverfrom a software-initiated spin down without rebooting the system or cycling power. To properly support power

management on SCSI drives and to ensure that the operating system responds to appropriate driver calls, the STOP/START UNIT command must be implemented as defined in the SPI (SCSI-3) standard.

ATAPI Storage

This section defines the requirements for all ATAPI storage devices.

[10.9] Peripherals comply with ATA/ATAPI-5

The ATA/ATAPI-5 standard defines hardware and software design guidelines for ATAPI devices.

[10.12] ATAPI devices support DEVICE RESET command

ATAPI devices must respond to the DEVICE RESET command regardless of their internal state, as defined in the ATA/ATAPI-5 standard. The controller can be reset entering a power-on state (requests cleared, signature present), but any non-default mode values must be left in their current state with the DRV bit unchanged.

Devices that do not implement the PACKET command feature set, such as hard disk drives, must not implement the DEVICE RESET command.

[10.18] ATA device supports ATA STANDBY command

ATA drives must implement the ATA STANDBY command, as defined in the ATA/ATAPI-5 standard.

Information on system power states and transitions can be found in *Storage Device Class Power Management Reference Specification, Version 1.0.*

Checklist for Storage

[18.1] Storage components and optical devices support bus master capabilities

[18.2] Removable media devices support media status notification

[18.5] Device Bay storage device complies with Device Bay 1.0 and other specifications

[18.6] ATA devices support Ultra DMA

[18.15] If implemented, SMART-compliant hard drive meets data-handling requirements

[18.16] CD device provides 8x minimum transfer rate or better performance

[18.17] CD drive is CD-enhanced compatible

[18.18] CD drive supports specified logical and physical CD formats

[18.19] ATA/ATAPI CD drive complies with MMC-2

[18.20] CD drive supports multisession and compatibility forms of the READ_TOC command

[18.21] ATA/ATAPI CD changer complies with the MMC-2 standard

[18.22] CD device supports digital audio detection

[18.23] CD and DVD devices use push-to-close design

[18.24] Block rewritable optical ATAPI device complies with SFF 8070i v1.1 or later

[NEW.18.102] DVD drive reads all DVD formats

[18.25] DVD device provides 2x minimum transfer rate or better performance anywhere on the disc

[18.26] [REDUNDANT] DVD drive and controller support bus master DMA transfers

[18.27] DVD drive meets minimum compatibility requirements

[18.28] DVD drive complies with the MMC-2 standard

[18.30] DVD drive supports defect management

[18.31] DVD drive supports copyright protection

[18.37] Device and controller comply with Storage Device Class Power Management Reference Specification

[18.39] [REDUNDANT] Device drivers and installation meet PC 2001 requirements

[18.40] Device driver runs in protected mode following installation

[18.41] Applications provided with the device meet Win32 requirements

[18.42] Device driver for partitioned media supports all Windows 98 and Windows 2000 partition types

[18.43] Device driver for block-mode device supports extended BPBs

[11.5] [REDUNDANT] Connector complies with bus standards and bus type is clearly indicated on connector

[11.6] Differential devices support DIFFSENS as defined in SPI standard

[11.10] Controller and peripherals implement SCSI bus data protection signal

[11.12] External devices use automatic termination or an accessible termination switch

[11.22] Devices supports the STOP/START UNIT command as defined in the SPI-3 or later standard

[10.9] Peripherals comply with ATA/ATAPI-5

[10.12] ATAPI devices support DEVICE RESET command

[10.18] ATA device supports ATA STANDBY command

C H A P T E R 1 4 A

Modems

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Voiceband ~~(POTS)~~ Modems

This chapter covers modems that connect directly or indirectly to the Public Switched Telephone Network (PSTN). These include:

?? Voiceband modems used for data, fax, voice, text telephony, or video telephony

?? ISDN modems

?? Cellular and wireless modems (for example, GSM)

[19.41] Modem driver supports Unimodem

The device driver must include Unimodem support. Typically, this requires a modem INF file, developed and verified using the MDK and pretested by the modem manufacturer.

[19.2] Modem controller ~~meets PC 2001~~ requirements

The modem controller must support the following:

~~? V.250 (formerly V.25 *ter*)~~

?? AT command buffer of at least 60 characters

?? Semicolon (;) character dial string modifier, except when the modem is configured for operation in those countries that prohibit this dial modifier

?? Universal Modem Driver (Unimodem) Diagnostics command, AT#UD

?? Capable of software-based feature upgrades; provide upgradable ROM or Windows driver-based modem

[19.3] Modem supports V.250 AT command set

Note to Reviewers: Require buffer size control command here.

International Telecommunication Union (ITU) Recommendation V.250 is a superset of the TIA-602 basic AT command set with significant and useful improvements. ~~It includes these new components:~~

~~? A standard format for extending the AT command set, with standard means for the PC to test the range of supported values for each command. This enables adaptive modem installation.~~

~~? Standard extensions for modem ID, port control, modulation control and reporting, error control, and data compression control and reporting. These reduce or eliminate the need for data-modem INF files.~~

~~Related RecommendationV.251, formerly known as Annex A/V.25 *ter*, provides standard commands that enable the PC to use V.25, V.8, and V.8 *bis* call control features for point-to-point data calls, voice/data/video calls, and voice-to-data transitions.~~

If the AT command for a particular function is implemented, the corresponding V250 AT command must be supported.

~~However, any modem function controllable by way of the AT command must be controllable by the appropriate V.250 command if one is defined in V.250 for that function. Optionally, the function also can be controlled by a proprietary command. Similarly, any reportable modem event must use the report defined in V.250, if one exists.~~

The essential V.250 commands are the following:

?? All basic mode commands from TIA-602 (no + prefix)

?? Identification: +GMI, +GMM, +GMR, +GCI

?? Port control: +IPR, +ICF, +IFC, +ILRR

?? Modulation: +MS, +MR, +MA

?? Error control: +ES, +ER, +EB, +ESR, +ETBM

?? Compression: +DS, +DR

The modem must also be able to generate appropriate V.250 responses enabled by the +ILRR, +MR, +ER, and +DR commands. ~~The standard format allows a future modem installer to adaptively install and use a modem, with minimal need for INF-file minidrivers.~~

[19.4] Data modem requirements~~Modem supports V.90 (1998) analog modem modulation~~

A PC 2001 modem must support:

?? V.90 modulation

?? V.42 LAPM error control

?? V.42*bis* data compression

?? V.80 synchronous data access protocol

~~ITU-T Recommendation V.90 modulation supports pulse-code modulation (PCM) connections to digitally connected central sites, at data rates from 56 Kbps down to 28 Kbps.~~

~~V.90 support implies support for V.34, which is used for analog-to-analog connections and for connections to central sites from users whose telephone lines do not support V.90 operation, at speeds from 33.6 Kbps down to 2400 bps.~~

~~*Mobile PC Note*~~

~~For mobile PCs, if modem capabilities are integrated in the base platform, then V.34 or higher is required. All other requirements for modems must be met as defined in this chapter.~~

[19.6] [REDUNDANT] Modem supports V.42 LAPM, V.42 *bis,* and V. 80 Synchronous Access data protocols

Note to Reviewers: This guideline is redundant with new guidelines presented in [19.4]

[19.7] Modem supports call control signaling, controlled using V.251 modem commands

To comply with PC 2001 requirements, ~~V.90 and V.34~~ modems must support the ITU ~~Recommendations V.8, V.8 *bis,* and Recommendation~~ V.251 standard for PC-controlled call control, including:

~~ITU Recommendation V.8 *bis* provides for the negotiation and selection of call functions between end points, and enables smooth voice-to-modem transitions during a call. V.8 *bis* is required for multimedia modes such as V.61 Analog Simultaneous Voice and Data (ASVD) and V.70 Digital Simultaneous Voice and Data (DSVD). Also, V.8 *bis* is used to negotiate the use of manufacturer-specific modulations and features. V.8 *bis* defines code points for V.42 and V.80 modes of operation. It enhances the basic call function selection embodied in the recommendations for V.25 and V.8.~~

~~ITU Recommendation V.251 enables the PC to participate in call control, allowing flexibility and a visual user interface as well as saving modem complexity. At a minimum, the V.251 implementation must:~~

?? Support DCE-controlled V.8 operation with DTE notification

?? Support DTE-controlled V.8 operation (<a8a> values of 2, 3 and 4)

?? Support DTE-controlled V.8bis operation

?? Support backward compatibility for media detection with terminals using V.25 signaling, for example, data calling tone and fax calling tone

?? Support backward compatibility for media detection with older modems, for example, V.32 and V.32 bis

?? Provide a means for turning on the V.8 Calling Indicator (CI) signal for originating calls

?? Meet requirements stated in the Intel *The Video-Ready Modem Handbook*

~~?~~

Note: V.8 and V.8bis are required to support V.34 and V.90 modem operation.

~~Support V.8 operation that is controlled by Data Circuit-Terminating Equipment (DCE) with Data Terminal Equipment (DTE) notification~~

~~? Support DTE-controlled V.8 bis operation~~

? Support backward compatibility for media detection with terminals using V.25 signaling, for example, data calling tone and fax calling tone

? Support backward compatibility for media detection with older modems, for example, V.32 and V.32 bis

? Provide a means for turning on the V.8 Calling Indicator (CI) signal for originating calls

The *Video-Ready Modem Handbook* specification from Intel Corporation describes an example using V.251 for call control and call function selection. The specification also gives implementation guidance for the use of V.80 in low-latency applications.

To support media detection in future Microsoft Back Office® family of products, it is recommended that the V.251 modem implement the <a8a> codepoints for DTE-controlled operations (2, 3, and 4).

[19.8] FAX modem supports 14.4 Kbps (V.17) with Class 1 command set

If fax modem capabilities are implemented, the fax modem must support 14.4 Kbps (V.17) with the Class 1 (TIA-578-AITU T.31) command set.

In addition to the required fax capabilities, the following enhanced capabilities are recommended for fax modems:

? Class 1.0 (ITU T.31) with +FAR support, which allows the hardware to perform adaptive carrier detection

? Class 2.0 (ITU T.32 or TIA-592) for rack-mounted server modems

? Adaptive DATA/FAX call classification based on the Class 2.0 +FAA command or equivalent (for example, +FAE), particularly for rack-mounted server modems

If fax modems include dax/data media detection (for example, T.32 +FAA command), the INF must include the necessary registry keys, as defined in the Modem Developers Kit, part of the Windows DDK.

Windows includes fax modem support. Windows 2000 and future versions of Microsoft BackOffice family of products will support Class 1.0 and Class 2.0 fax modems and adaptive FAX/DATA call classification. To benefit from this support, modem vendors should extend their modem INF files to support the registry keys for these features, as defined in the Windows Modem Developers Kit (MDK).

[19.9] If delayed and blacklisted number tables are implemented, modem clears its tables when off hook

Note to Reviewers: Is this guideline still an appropriate requirement?

This support is required for modems supporting delayed and blacklisted number tables. The modem must clear its delayed and blacklisted number tables if the associated handset goes off hook..

During certain international Post, Telephone, and Telegraph (PTT) certification processes, modems must support the delayed and blacklisted numbers feature. These regulations require operator intervention to clear these tables. For details, see ETSI ETS 300 001.~~That means that When the modem fails to connect to a specific number for a certain number of times, the dialed number is stored in an internal list. Subsequent automated dialing operations to this number are either delayed for a time or might be forbidden until some form of manual intervention occurs (blacklisted). The international certification processes specify that manual intervention using an external deviceis required in order to clear these numbers.~~

For Windows compatibility, modems that support delayed and blacklisted number tables must:

?? Generate end-user legible error messages to report these conditions.

?? Provide modem INF drivers that translate these error messages for Unimodem and TAPI.

~~Windows provides error messages corresponding to delayed and blacklisted error reportsin order to reduce customer confusion.~~

[19.10] If TDD support is implemented, modem supports TDD, meeting V.18-1996 with V.250 AT commands

People who are deaf or hard of hearing can use Telephone Device for the Deaf (TDD), also known as Text Telephones, to communicate over phone lines.

ITU Recommendation V.18 codifies how all these devices work and how to adaptively connect to all of them. ITU Recommendation V.250 contains these AT commands for control of V.18 features in a modem: +MV18S, +MV18R, +MV18AM, +MV18P. Modems that support text telephony must support those parts of V.18 applicable to their target countries, and the above listed V.18 commands.

~~The U.S. Americans with Disabilities Act (ADA) requires all businesses of a certain size or larger to have Text Telephone services available and to be able to receive calls from people using Text Telephones.~~

~~It is recommended to include Text Telephone capability for the type commonly used in the country of sale and use, such as Baudot in the United States, Minitel in~~

France, and so on. In North America and Europe, the following types of Text Telephones are used:

? Baudot: 45 or 50 bps Frequency-Shift-Keyed (FSK) and 5-bit Baudot coding

? ASCII: 300 bps Bell 103 and 7-bit ASCII coding

? European Deaf Telephone (EDT): 110 bps half-duplex V.21 and 7-bit coding

? Minitel: V.23 modems and 7-bit coding

? Modems and 7-bit coding

? Dual-tone multifrequency (DTMF): 2-digit or 3-digit character coding

[19.11] If voice mode is implemented, voice modem supports ITU V.253 (AT+V)

ITU V.253 supersedes TIA IS-101-1994. If voice modem features are implemented, the corresponding commands and responses defined in V.253 must be used.

Note to Reviewers: Do we need voice modems in the design guide?

This requirement includes support for +VTR (full-duplex voice).

TIA IS-101-1994, the interim standard for Voice DCE, has been superseded by TIA-695. TIA-695 adds voice formats and speakerphone control commands. ITU-T V.253 (formerly V.voice) was completed in January 1998 and is a superset of the TIA-695 U.S. standard. V.253 includes small corrections to TIA-695 and adds provisions for bi-directional, digitized voice over the serial port.

The following voice modem features are recommended:

? Sense local telephone line state (on hook/off hook) without the modem going off hook

? Extension (parallel) telephone answer and hang-up detection and reporting

? Programmable gain control for all audio channels

? Remote (far end) telephone answer and hang-up detection and reporting

? Message waiting signal (stuttered dial tone) detection reporting

? Special Information Tone (SIT) detection and reporting

? Distinctive ring detection and reporting

? Powered interface to the local telephone to support voice I/O and DTMF I/O

It is not required for A voice modem can implement any recommended feature to implement every feature in this list.

[19.12] If implemented, V.253 modem supports duplex audio (+VTR)

The required formats for duplex audio are for 8-bit 8kHz: unsigned linear, vG.711. In duplex audio, support for a Line Echo Canceller, as described in V.253, is required.

[19.13] If Called ID detection is implemented, modem supports Caller ID Reporting using +VCID and +VRID commands

Caller ID reporting is controlled with the AT+VCID and AT+VRID commands from V.253. ~~As specified in V.253, Caller ID reporting is available in operating modes other than FCLASS 8 (Voice Mode). Therefore, it is recommended that he modem support the AT+VCID and AT+VRID commands even if Voice Mode is not supported.~~

[NEW.19.102] If voice mode is implemented in the modem, voice modem supports streaming audio

Note to Reviewers: Explanation to be provided in later draft.

[19.14] [DELETED] Voice modem supports speakerphone

Note to Reviewers: With +VTR explicitly required, this requirement is no longer needed

[19.23] Modem pair passes basic V.34 file transfer test

TIA standard TSB-38 specifies test procedures for evaluating modems. Test file **4.TST** contains random data and does not benefit from data compression.

This requirement is a basic test of modem functionality and verifies that the modem is able to connect at 31.2 Kbps, to stay connected, and to transfer data on a clean line for at least a half-hour, which is a typical time period for a modem session.

While operating in V.34 modulation on TIA TSB-37A line 18C2, the modems must be able to transfer 256 repetitions of the TSB-38 test file **4.TST** in 40 minutes or less, simultaneously in both directions, without hanging up or otherwise aborting the transfer. V.42 LAPM is enabled during this test. Data transmission runs directly on the modems without the use of an additional protocol such as Zmodem.

Impairment combination 18C2 in the TIA TSB-37A PSTN consists of very mild impairments. No V.34 modem should have difficulty operating on this line at least 31.2 Kbps.

Note: For modems certified for operation only in those countries outside of North America, impairment combination 2C4 as specified in ITU-T Recommendation V.56 *bis*, can be substituted for TSB-37A line 18C2. Recommendation V.56 *bis* is an international equivalent of TIA TSB-37A.

[19.24] Modem pair passes basic call connect reliability test

This requirement is a basic test of modem functionality and verifies that the modem can reliably connect a large number of times on good telephone channels.

While operating in V.34 modulation, the modems must be able to perform four repetitions of the Call Connect vs. Test Loop Combination test defined in TIA TSB-38 (476 total connection attempts), with an overall call completion success ratio of 97 percent, and with neither modem stalling in an unresponsive, inoperable state.

As specified in TSB-38, the test channels 17C1 though 17C7 are used in this test because impairment combination 17C represents more than 55 percent of the combinations in the PSTN model defined in TSB-37A.

At the conclusion of each connection or connection attempt during the test, the modem port will be closed and then reopened for the next attempt.

Note: For modems certified for operation only in those countries outside of North America, the Call Connect Reliability Test specified in ITU-T Recommendation V.56 *ter*, can be substituted for that in TSB-38. Recommendation V.56 *ter*, an international equivalent of TIA TSB-38, specifies use of the PSTN model defined in Recommendation V.56 *bis*.

[19.25] Modem pair passes concurrency test

In this series of concurrency tests, the modem pair runs while a series of representative communications applications are running on the PC, for example, e-mail, web browsing, and H.263+ video teleconferencing.

[19.32] [REDUNDANT] Each hardware device has a unique Plug and Play device ID

[19.33] [REDUNDANT]Each device has a Plug and Play compatible ID

[19.34] [REDUNDANT] Dynamic resource configuration is supported for all devices

[19.35] [REDUNDANT] Modem meets PC 2001 requirements for PCI bus devices

Note to Reviewers: These basic PC 2001 requirements are no longer repeated in every chapter

[19.36] External modem supports USB specifications~~USB modem meets PC 2001 requirements for USB bus devices~~

A modem that uses USB must comply with all related USB specifications, including:

?? *USB Specification, Version 1.1* ~~or later~~

?? *Universal Serial Bus Device Class Definitions for Communications Devices, Version 1.0* ~~or later~~

External modems may also support V.24 (RS-232) serial interfaces for legacy connectivity.

For compatibility with Unimodem and Windows USB serial drivers, a USB modem that incorporates the modem controller function must support the mandatory and optional requests and notifications for Abstract Control Model Serial Emulation defined in section 3.5.1.2.1 of the *USB Class Definitions for Communications Devices* specification.

[19.37] Device Bay modem meets PC 2001 requirements

A modem designed as a Device Bay peripheral must interface with USB, IEEE 1394, or both buses. If implemented to use the USB bus, the device must support relevant USB device class specifications. All Device Bay peripherals must meet the requirements defined in *Device Bay* ~~*Interface*~~ *Specification, Version 1.0* or later.

[19.38] Modem complies with device class power management reference specification

Support for power states D0 and D3 cold are required for PCI modems, including wake on ring.

The *Communications Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions for the OnNow device power states (D0–D3) for modems. The specification also covers the device functionality expected in each power state and the possible wake-up event definitions for the class.

Power states D0 and D3 are required for modems on power-managed buses, including PCI, CardBus, and USB.

Modem adapters that use the PCI bus must be capable of generating a power management event (PME# assertion) from the D3 cold device state. ~~It is recommended that Modem adapters also support capture of Caller ID with hardware support for the AT+VRID "resend caller ID" voice modem command.~~

[19.39] Modem supports wake-up events

A modem must be able to cause a wake-up event on an incoming ring as defined in *Communications Device Class Power Management Reference Specification.* This requirement applies for modems on all power-managed buses, including PCI, CardBus, and USB.

The D2 power state is defined specifically for this purpose in the power management reference specification. The ability for a modem to cause a wake-up event from the D3 power state is also possible, and using the D3 state is

recommend because it realizes better system power savings. To comply with this requirement, a modem must be able to cause a wake-up event from the D2 state, the D3 state, or both states.

~~Because caller-ID reporting would be missed by PCs while in a sleep state,the ability for a modem to retain and repeat the last caller-ID reporting on demandis recommended. The mechanism for doing this is described in *Communications Device Class Power Management Reference Specification* and in the V.253 voice modem specifications.~~

PCI devices are required to support D3 cold on a PCI 2.2-based system with auxiliary power. On all other power-managed buses (such as USB), support for either D2 or D3 is acceptable.

[19.40] [REDUNDANT] Modem drivers meet PC 2001 requirements for device drivers and installation

Note to Reviewers: This basic PC 2001 requirement is no longer repeated in every chapter

~~**[19.42] [DELETED] Applications provided with modem meet Win32 requirements**~~

Note to Reviewers: This information has been moved to the Telephony section.

Driver-based Modems

This section covers requirements for controller or “soft” modems, whereby the modem controller function, or both the modem controller and the modem datapump functions, are implemented on the Windows host.

[NEW.19.103] If implemented as an industry standard riser card, the modem subsystem complies with applicable standard Plug and Play requirements

All industry standard riser card specifications must provide means for the device to uniquely identify itself, so that the system (including the BIOS) can generate unique PCI SVID and SDID. Riser devices, including modems, must supply a unique device ID for each version of the riser that needs a different driver.

The Audio Modem Riser (AMR) card specification is an example of an industry standard device subsystem riser.

Note to Reviewers: Specification details will be provided in a future draft.

[19.26] Driver-based modem uses a WDM-based driver solution

Note to Reviewers: These requirements will be redefined in a future draft.

Windows 98 and Windows 2000 share WDM kernel calls. Driver-based modems must use the WDM kernel so that both operating systems can use a common driver binary. For Windows 2000, these drivers must also support symmetric multiprocessors.

ISDN Modems

This section covers requirements for serial-port connected ISDN Terminal Adapters, commonly referred to as "ISDN modems."

~~**[19.17] [DELETED] ISDN driver supports unattended installation, with limitations**~~

Note to Reviewers: This item is now obsolete.

[19.18] ISDN modem supports required command set

An ISDN modem must support the following:

?? Basic AT commands, such as TIA-602, which is a subset of ITU V.250

?? Commands to select the end-to-end protocol used over the ISDN, for example, synchronous PPP, V.110, V.120, and so on

?? Commands to set the switch type, subscriber numbers, or directory numbers

?? SPID or EAZ (where applicable) for user selection or if auto-detection fails, implemented in the device or in the communications driver

~~**[19.19] [DELETE] ISDN modem exposes both B channels**~~

Note to Reviewers: Recommendations are not included in PC

[19.20] ISDN modem supports asynchronous-to-synchronous conversion, RFC 1662

~~These types of ISDN devices are treated as modems, not as internal ISDN devices supported using NDIS WAN miniports. In the external case, the primary implication is that the operating system will send byte-level PPP (also known as asynchronous PPP). In the NDIS WAN case, the implication is that the operating system will send bit-level PPP (also known as synchronous PPP).~~

Because ISDN is a synchronous service and an ISDN modem connects to a logic asynchronous port on the PC (USB), the device must provide some means of

converting asynchronous data to synchronous data (synchronous PPP, RFC 1662).

~~**[19.21] [DELETE] ISDN modem defaults to HDLC PPP after INF installation**~~

Recommendations are not included in PC 2001

[19.22] [REDUNDANT] ISDN modem uses high-speed port

Note to Reviewers: This guideline was consolidated with [19.36]

Mobile Modems

This section covers the particular requirements of modems used in mobile systems. These are in addition to the Voiceband Modem guidelines identified in a previous section.

~~**Note:** The presence of a CardBus slot on the mobile PC meets the requirements for providing a communications device.~~

[19.15] If wireless support is implemented, Mobile PC modem supports +WS46 command

Wireless modems and look-alike modems include the common types, such as North American analog cellular, cellular digital packet data (CDPD), global system for mobile communications (GSM), and other digital cellular systems, and several other types, such as the Ricochet modem from Metricom.

All wireless and cellular modems must use the ~~commands in TIA-678are recommended.. The~~ +WS-46 command, which selects the wide area network (WAN).

The TIA-678 +WS46 command has codes to indicate which system the modem is capable of. For example, the following values, quoted from Table 4 of the standard, are useful.

Value	System
1	Public telephone network (that is, a normal wireline modem)
4	CDPD
7	TIA-553 analog cellular system
10	Metricom Ricochet network
12	GSM digital cellular system
13	TIA IS-95 CDMA digital cellular
14	TIA IS-136 TDMA digital cellular (Personal Communications System [PCS])

Windows has registry keys that support analog cellular modems. Windows also supports data access in GSM and other wireless modem types. Participants in the Mobile Data Initiative are developing extensions for other services on digital cellular modems, as described in the following requirement.

[19.16] If digital cellular control is implemented, Mobile PC modem supports appropriate +C digital cellular standards

If digital cellular support is implemented, the following appropriate digital cellular control standards must be supported:

Standard	System and services
GSM 7.07	GSM system: data, fax, voice
GSM 7.05	GSM SMS
TIA IS-707	North American CDMA: data and fax
TIA IS-135	North American TDMA: data and fax

The following commands are required:

~~TIA-678 +WS-46 selector command~~

+CBC battery power monitoring command

+CPAS phone activity status

+CSQ signal quality monitoring command

Class 2.0 facsimile services, per appropriate standard

For GSM modems, +CBST protocol selection command

Digital cellular communications equipment must default to using error correction on the radio link. For example, for GSM 7.07, the modem must initialize to +CBST=,,1 (which selects a “nontransparent” air interface).

To allow data cards to use GSM/ISDN V.110 “fast access” where available in the network, +CBST=71,, (9600 bps V.110) must be a valid setting.

[NEW.19.106] If Short Messaging Services support is implemented, the modem supports appropriate +C SMS control commands

To allow software applications to specify settings and manipulate Short Messaging Service (SMS) through a GSM modem card, the card must support the following GSM 07.05 commands.

+CMGF: Message Format

+CMGL: List Messages

+CMGR: Read Messages

+CPMS: Preferred Message Storage

+CRES: Restore Settings

+CSAS: Save Settings

+CMGS: Send Messages	+CSCA: Service Center Address
+CMGW: Write Messages	+CSCS: TE character set selection
+CNMI: New Message Indications to terminal equipment (TE)	+CSMS: Select Messaging Service

Unlike wireline data modems, these devices are not required to support V.34 signaling because none is available. Only 9600 bps capability is required.

~~Class 1.0 fax support is available on some of these devices, but it is not required; the error rates with transparent modem faxes are often very high.~~

~~Cellular telephone systems are widely deployed in the industrialized world and are now being deployed internationally. In North America, analog cellular systems (TIA-553) are currently predominant, although two types of digital cellular systems can also be deployed: code division multiplexed access (CDMA; TIA IS-95) and time division multiplexed access (TDMA; IS-136).~~

~~In Europe and the rest of the world, the GSM digital cellular system is widely deployed. In Europe, the infrastructure for data, fax, and short messaging is now in place.~~

~~For all three digital cellular systems, the system design has been extended to offer data, fax, voice, and SMS to mobile users. In all cases, a modem pool is added to the ground stations, where connection is made to the Public Switched Telephone Network (PSTN). Access to the logical serial ports of these modems is made using the digital error-controlled radio link to the equipped mobile phone and is exposed on a serial port or associated PC Card device.~~

~~Digital cellular communications equipment should default to using error correction on the radio link. For example, for GSM 7.07, the modem should initialize to +CBST=,,1 (which selects a "nontransparent" air interface).~~

~~To allow data cards to use GSM/ISDN V.110 "fast access" where available in the network, +CBST=71,, (9600 bps V.110) should be a valid setting.~~

~~The AT command sets for these digital cellular phone systems are contained in the following standards.~~

~~Standard~~	~~Command set~~
~~GSM 7.07~~	~~GSM system: data, fax, voice~~
~~GSM 7.05~~	~~GSM SMS~~
~~TIA IS-707~~	~~North American CDMA: data and fax~~
~~TIA IS-135~~	~~North American TDMA: data and fax~~

~~The TIA-678 +WS46 command has codes to indicate which system the modem is capable of. For example, the following values, quoted from Table 4 of the standard, are useful.~~

~~Value~~	~~System~~
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~~10~~	~~Metricom Ricochet network~~
~~12~~	~~GSM digital cellular system~~
~~13~~	~~TIA IS-95 CDMA digital cellular~~
~~14~~	~~TIA IS-136 TDMA digital cellular (Personal Communications System [PCS])~~

Telephony

Note to Reviewers: Introductory text to be added.

[NEW.19.104] System with telephony applications uses a common set of audio I/O devices for system audio and telephony applications

If the system enables telephony applications such as speakerphone, IP telephone, and so on, for each type of audio I/O device, the same device must be usable for both system audio and telephony. For example, the same set of speakers must be usable for both system audio and speakerphone functions. When using a headset, users must not need to change plug locations when switching from listening to CD-audio to speaking on the phone.

[NEW.19.105] Telephony applications provided with a PC 2001 system meet industry telephony performance guidelines

If the system enables telephony applications such as speakerphone or IP telephone, the applications provided with the system must comply with telecomm industry guidelines for such parameters as send and receive loudness, echo, and so forth.

For speakerphone applications, the guidelines in ITU-T Recommendation P.340, *Transmission characteristics of hands-free telephones*, are applicable. Otherwise, ITU-T Recommendation P.310, *Transmission characteristics for telephone band (300-3400 Hz) digital telephones*, is applicable. U.S. Committee T1 Technical Report No. 56, *Performance guidelines for voiceband services over hybrid internet/PSTN connections*, provides useful guidance for IP telephony functions.

Checklist for Modems

[19.41] Modem driver supports Unimodem

[19.2] Modem controller requirements

[19.3] Modem supports V.250 AT command set

[19.4] Data modem requirements

[19.6] [REDUNDANT] Modem supports V.42 LAPM, V.42 bis, and V. 80 Synchronous Access data protocols

[19.7] Modem supports call control signaling, controlled using V.251 modem commands

[19.8] FAX modem supports 14.4 Kbps (V.17) with Class 1 command set

[19.9] If delayed and blacklisted number tables are implemented, modem clears its tables when off hook

[19.10] If TDD support is implemented, modem supports TDD, meeting V.18-1996 with V.250 AT commands

[19.11] If voice mode is implemented, voice modem supports ITU V.253 (AT+V)

[19.12] If implemented, V.253 modem supports duplex audio (+VTR)

[19.13] If Called ID detection is implemented, modem supports Caller ID Reporting using +VCID and +VRID commands

[NEW.19.102] If voice mode is implemented in the modem, voice modem supports streaming audio

[19.14] [DELETED] Voice modem supports speakerphone

[19.23] Modem pair passes basic V.34 file transfer test

[19.24] Modem pair passes basic call connect reliability test

[19.25] Modem pair passes concurrency test

[19.32] [REDUNDANT] Each hardware device has a unique Plug and Play device ID

[19.33] [REDUNDANT]Each device has a Plug and Play compatible ID

[19.34] [REDUNDANT] Dynamic resource configuration is supported for all devices

[19.35] [REDUNDANT] Modem meets PC 2001 requirements for PCI bus devices

[19.36] External modem supports USB specifications

[19.37] Device Bay modem meets PC 2001 requirements

[19.38] Modem complies with device class power management reference specification

[19.39] Modem supports wake-up events

[19.40] [REDUNDANT] Modem drivers meet PC 2001 requirements for device drivers and installation

[NEW.19.103] If implemented as an industry standard riser card, the modem subsystem complies with applicable standard Plug and Play requirements

[19.26] Driver-based modem uses a WDM-based driver solution

[19.18] ISDN modem supports required command set

[19.20] ISDN modem supports asynchronous-to-synchronous conversion, RFC 1662

[19.22] [REDUNDANT] ISDN modem uses high-speed port

[19.15] If wireless support is implemented, Mobile PC modem supports +WS46 command

[19.16] If digital cellular control is implemented, Mobile PC modem supports appropriate +C digital cellular standards

[NEW.19.106] If Short Messaging Services support is implemented, the modem supports appropriate +C SMS control commands

[NEW.19.104] System with telephony applications uses a common set of audio I/O devices for system audio and telephony applications

[NEW.19.105] Telephony applications provided with a PC 2001 system meet industry telephony performance guidelines

C H A P T E R 1 4 B

Network Communications

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

Network Communications

This chapter presents requirements for network adapters and related networking technologies.

Network communications requirements are based on Network Driver Interface Specification (NDIS) 5.0, which defines the networking requirements, services, terminology, and architecture for the Windows family of ~~Windows 98 and Windows 2000~~ operating systems. For background information about NDIS 5.0, see the web site at http://www.microsoft.com/hwdev/network/.

Note: In this chapter, references to adapters, network interfaces, and so on should be taken to apply to add-on network adapter cards, network implementations on the system board, and external network interfaces equally and without preference for any of these types of implementation, unless otherwise noted.

Unless a specific requirement or exception is defined in this chapter, all requirements apply for networking solutions as presented in Chapter 4, "PC 2001 Core System Guidelines," and Chapter 8, "Buses and Interfaces." In some cases, the specification or standard for a particular medium provides implementation options. Sections of this chapter dealing with a specific network medium may place requirements on how those options are handled.

Note: If new networking medium emerge by the time these requirements take effect, implementations of such a medium must comply with the general network device requirements.

System Guidelines for Network Communications

This section summarizes the network communications features required for PC 2001 systems.

Network Adapter Guidelines

This section defines basic hardware feature requirements for network adapters. Many of these requirements also apply to other network communications devices such as ISDN, cable modem, and ADSL. The applicable requirements for each device category are listed in the related sections later in this chapter.

[20.7] Network adapter uses NDIS 5.0 miniport driver

The network adapter driver must be based on and comply with NDIS 5.0 in order to take advantage of new operating system capabilities. The driver must follow the NDIS miniport driver model defined in the Windows 2000 Device Driver Kit (DDK).

Important: The development of full MAC drivers is no longer supported. Support for full MAC drivers in the operating system will be removed in future versions of Microsoft Windows family of operating systems.

If the network device is for connection-oriented media, such as ATM, ISDN, frame relay, or X.25, it must have a connection-oriented miniport driver that follows the connection-oriented model defined for NDIS 5.0 in the Windows 2000 DDK. Also, for connection-oriented media, there needs to be an NDIS 5.0 call manager driver as defined in the DDK.

In some cases, such as ATM, the call manager driver is included in the operating system. Consequently, for an ATM adapter, the vendor needs to provide only an NDIS 5.0 connection-oriented miniport driver. For connection-oriented media such as ISDN or X.25, the vendor must provide a call manager driver with the hardware, because the call manager is not included in the operating system. Call manager support can be integrated in the connection-oriented miniport driver or implemented as a separate NDIS 5.0 call manager driver. Documentation for both integrated and separated call managers is included in the Windows 2000 DDK.

An intermediate NDIS 5.0 miniport driver is required for network adapters that connect to the PC using IEEE 1394 or USB buses. This driver exposes its media type to NDIS at its upper edge, and it interfaces with the appropriate bus driver (IEEE 1394 or USB) at its lower edge.

[20.8] Intermediate NDIS 5.0 miniport driver is deserialized

NDIS 5.0 introduces support for deserialized miniports. This enables performance improvements and scalability on Windows 2000 multiprocessor systems.

For serialized miniports, NDIS simplifies the driver development by implementing the lock and queue management on behalf of the minport driver. When these drivers are called, NDIS is always called before the miniport driver is entered, which enables NDIS to maintain the lock states and manage the queues of serialized miniport drivers.

This is not always the case with intermediate minport drivers, where the driver can be called directly by another driver outside NDIS, such as the USB bus driver. Therefore, intermediate miniport drivers should be written as deserialized drivers implementing the lock and queue management in the driver.

[20.10] Adapter automatically senses presence of functional network connection

Where the network allows it, the network adapter must be capable of dynamically determining whether it is functionally connected to a link partner such as a hub, switch, or router. The device must indicate the link state in the following cases:

?? At boot time

?? After returning to D0 power state

?? When the link state changes while in the D0 power state (no time limit is specified for the required detection or status indication)

If the adapter is on an expansion card that is not used as a boot device, the device drivers can determine the presence of the functional link. If the adapter is not functionally connected to a link partner, the miniport driver must provide appropriate NDIS status indication using support for cable sense in NDIS 5.0.

For information about NDIS status codes and indication mechanisms, see the Windows 2000 DDK.

[20.11] Adapter automatically senses transceiver type

Network adapters that support multiple transceivers must be capable of automatically detecting which transceiver type is connected to the network unless detection is not possible with the network media available. The network adapter then must automatically drive the correct connection. In all cases, the user must not be required to set jumpers or manually enter information to inform the operating system of the transceiver type.

[20.12] Adapter can transmit packets from buffers aligned on any boundary

Buffer alignment refers to whether a buffer begins on an odd-byte, word, double word, or other boundary. Adapters must be able to transmit packets, any of whose fragments are on an odd-byte boundary.

For performance reasons, packets must be received into contiguous buffers on a double word boundary.

[20.13] Adapter communicates with driver across any bridge

If the adapter uses a bridge, all communications must be free of errors across any bridge, such as a PCI bridge adapter.

[20.15] Adapter and driver support promiscuous mode

Promiscuous mode ensures that the adapter can be used with Microsoft Network Monitor Agent. This requirement applies only to LAN (non-switched) media.

Notice that, by default, promiscuous mode is not turned on. Enabling promiscuous mode must be possible only by using the Microsoft Network Monitor Agent or another similar administrative application.

[20.16] Adapter ~~is compatible with remote new system setup capabilities if can be~~ used as a boot device

A PC system using Windows 2000 (or later) must include remote boot support as defined in the Preboot Execution Environment (PXE) Specification, Version 2.0. This support may either be included on the adapter, in the system BIOS, or the support may be split between the adapter and the BIOS. (See [Core Chapter, Section xxxxx]: BIOS supports Preboot Execution Environment)

This is not a requirement for Cardbus adapters.

This is not a requirement for adapters intended for use in home networks.

~~On a system that uses a network adapter to support installation of the operating system, the network adapter must be compatible with remote new system setup capabilities as defined in the *Network PC System Design Guidelines, Version 1.0b*.~~

~~A Desktop PC system must have a network adapter that meets this requirement and the necessary system BIOS capabilities to use the adapter as a boot device, as defined in requirement 3.5, "BIOS meets PC 2001 requirements for OnNow support."~~

[20.17] PCI network adapters are bus masters

To improve the system performance by offloading the processor load, PCI network adapters must be bus masters.

[20.18] Device Bay-type network adapter meets PC 2001 requirements

Any network communications device designed as a Device Bay peripheral must interface with USB, IEEE 1394, or both, and must support relevant USB device class specifications. All Device Bay peripherals must meet the requirements defined in *Device Bay ~~Interface~~ Specification, Version 1.0.*

[20.19] If Implemented, USB or IEEE 1394 device meets specifications for network communications devices

Devices must meet requirements in USB 1.1 or later and IEEE1394.a or later.

Vendors are also encouraged to participate in the definition and implementation of USB and IEEE 1394 efforts.

[20.50] ~~Home~~ Networking media supports Internet Protocol (IP)

Any ~~home~~ networking media must support IP, yet not preclude the use of other protocols.

[20.20] [MOVED] Network adapter and driver supports priority for IEEE 802-style networks

IEEE 802 LAN Guidelines

[20.9] Full-duplex adapter automatically detects and switches to full duplex mode

If both the network adapter and switch port in a link pair support full duplex and there exists a standard way for each to detect and negotiate the duplex mode, the network adapter must negotiate full-duplex mode operation by default. Half-duplex mode can be used if that is the only mode supported by one or both link partners, or it can be manually configured if warranted by special conditions. The goal is to configure this setting automatically without end-user intervention.

[20.14] Adapter supports filtering for at least ~~32~~ 16 multicast addresses

This requirement applies to networking technologies such as Ethernet, that support multicast. This requirement does not apply to technologies such as Token Ring, which distributes Internet Protocol (IP) multicast traffic using the functional address as specified in RFC 1469.

This capability supports push technology applications such as Microsoft NetShow™ server, Active Desktop™ interface, and Internet Explorer 4.0 or later version. The minimum required capability is for filtering ~~32~~ 16 multicast addresses, also known as channels.

[20.20] Network adapter and driver supports priority for IEEE 802-style networks

Windows Quality of Service (QoS) components provide link layer priority information to NDIS 5.0 miniport drivers in each transmitted packet's NDIS_PER_PACKET_INFO structure.

Priority values are derived by mapping IETF Integrated Services (IntServ, RFC 1663) service typed to IEEE 802.1p priority values, referred to as the "user priority" object. ~~in the draft available on the web at http://search.ietf.org/internet-drafts/draft-ietf-issll-is802-svc-mapping-01.txt, which is likely to be superceded by later draft or final specification~~ Current IETF references include:

?? The Subnet Bandwidth Manager (SBM)
http://www.ietf.org/internet-drafts/draft-ietf-issll-is802-sbm-08.txt

?? Framework for integrated services over 802 networks
http://www.ietf.org/internet-drafts/draft-ietf-issll-is802-framework-07.txt

?? Mapping integrated services to 802.1p - http://www.ietf.org/internet drafts/draft-ietf-issll-is802-svc-mapping-04.txt

The intserv service type used for the mapping is determined by QoS-aware applications, or on behalf of the application, by QoS-aware operating system components. Driver support for link layer priority information must adhere to IEEE 802.lp priority values.

IEEE 802.1p/q-capable Ethernet drivers must use the priority level indicated in the NDIS_PER_PACKET_INFO structure to generate the responding field in the IEEE 802.1p/q MAC headers of transmitted packets. Similarly, these drivers must extract the appropriate information from the MAC headers of received packets and to copy the priority to the NDIS_PER_PACKET_INFO structure before indicating the packet to higher protocol layers.

Notice that any link layer driver has the ability to interpret the priority information in the NDIS_PER_PACKET_INFO structure and use it as appropriate for the particular media.

For more information, see the Windows 2000 DDK and "QoS: Assigning Priority in IEEE 802-style Networks," available on the web at http://www.microsoft.com/hwdev/devdes/qos.htm.

ISDN Guidelines

This section summarizes the design features for ISDN devices.

In this section, “internal ISDN device” refers to the ISDN terminal adapter, which exposes raw access to its B channels using NDIS miniports. Alternatively, NDIS miniports could be attached to the PC using WDM-supported bus classes such as USB or IEEE 1394, which would physically be an external device.

“ISDN modem” refers to an ISDN device that exposes itself as a modem controlled by the AT command set.

This section defines general requirements for ISDN and specific requirements for ISDN terminal adapters. For information about the requirements for ISDN modems, see Chapter 19, “Modems.”

[20.21] Internal ISDN device meets PC 2001 network adapter requirements

The ISDN device driver and its INF file must be based on NDIS 5.0 to ensure user-friendly installation and operation of the ISDN adapter.

The following requirements must be met, as defined in “System Requirements for Network Communications” earlier in this chapter:

?? 20.7, “Adapter uses NDIS 5.0 miniport driver, with call manager support” for connection-oriented media

?? 20.10, “Adapter automatically senses presence of functional network connection”

?? 20.12, “Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send”

?? 20.13, “Adapter communicates with driver across any bridge”

?? 20.18, “Device Bay-type network adapter meets PC 2001 requirements”

?? 20.19, If implemented, “USB or IEEE 1394 device meets specifications for network communications devices”

[20.22] Internal ISDN device supports synchronous HDLC framing

High-level data link control (HDLC) framing is a standard for sending synchronous data. Other framing methods are allowed if the miniport driver provides simple HDLC-framed, synchronous Point-to-Point Protocol (PPP) packets to NDIS.

[20.23] NDIS interface and driver support raw unframed synchronous B channel I/O

The internal ISDN device and the driver must support raw, unframed (non-HDLC) synchronous B channel I/O at 64 Kbps per B channel, with each

B channel individually accessible. This support enables H.320 as well as voice calls over ISDN without audio breakup.

For these raw interfaces, the direct path to each B channel must support synchronous transmission and reception of H.221 frames, which are of 20 ms duration. ~~To achieve this without additional latency to H.221, there must be support for overlapped I/O buffersat intervals of less than or equal to 20 ms in each direction. As~~ Since underruns or overruns cause degraded audio, hardware buffering must be adequate to prevent B channel underruns and overruns. For Windows 98 and Windows 2000, 20 ms is adequate.

Underrun and overrun prevention can be achieved by making buffering software configurable with adequate range to handle foreseeable real-world conditions. The miniport driver must make I/O completion callbacks to NDIS for each I/O buffer as soon as the I/O for that buffer is complete; it must not coalesce or delay callbacks.

[20.24] ISDN driver supports unattended installation, with limitations

Configuration of the dependent parameters, such as service profile IDs (SPIDs) and switch-type IDs, must be done through the ISDN Configuration wizard included in the operating system.

[20.26] ISDN device includes software-selectable terminating resistors

If the ISDN device has an S/T-interface for connecting additional ISDN devices, it must also have software-configurable terminating resistors that can be selected on or off. The default value of the termination is on in North America, but off in all other countries, where phone companies unconditionally provide the termination.

Cable Modem Guidelines

A cable modem connected to a PC is one system component that cable-television operators use to deliver high-speed cable data services to customers.

Cable modem provides two-way services: Data flows downstream from the cable operator's head end and upstream from the customer's PC. At the head end, the cable data system is terminated by the cable modem termination system (CMTS), which terminates the upstream and downstream radio frequency (RF), MAC layer, and possibly Layer 3 protocols from the cable side. CMTS provides the internetwork connection between the cable system and the rest of the network at the head end. CMTS can be implemented on a proprietary hardware platform or a PC platform running Windows 2000 to provide different networking functions such as routing or QoS support, for example, RSVP.

The three current cable modem specifications are:

?? Data-Over-Cable Service Interface Specification (DOCSIS), developed by the Multimedia Cable Network System (MCNS) consortium.

?? IEEE 802.14, developed by IEEE.

?? Digital Video Broadcasting/Digital Audio-Visual Council (DVB/DAVIC), developed by DAVIC and DVB and adopted by European Telecommunication Standards Institute (ETSI) and International Telecommunication Union (ITU).

Industry support for DOCSIS is growing rapidly in North America. In present form, its upper layers fully describe IP traffic encapsulated by 802.3/DIX Ethernet framing. ATM is left for future study.

External Ethernet DOCSIS cable modems provide IEEE 802.1d bridging for one or more Customer Premises Equipment. A PC attaches to the cable modems indirectly through its 10BASE-T network adapter. Integrated cable modems attach directly to the PC over buses such as USB, PCI, and IEEE 1394 and they require a vendor-supplied NDIS 5.0 miniport driver. This driver exposes an 802.3/DIX Ethernet adapter interface to the operating system and it interfaces to the cable modem hardware using the appropriate bus (PCI) or bus interface driver, USB or IEEE 1394 at its bottom edge.

In contrast to DOCSIS, both the IEEE 802.14 and the DVB/DAVIC efforts are focused on using ATM, typically implementing an ATM adapter interface and using an NDIS 5.0 ATM miniport driver.

[20.28] Integrated cable modem meets PC 2001 network adapter requirements

For the integrated cable modem, the following requirements must be met as defined in “Network Adapter Requirements” earlier in this chapter:

?? 20.10, “Adapter automatically senses presence of functional network connection”

?? 20.12, “Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send”

?? 20.13, “Adapter communicates with driver across any bridge”

?? 20.17, “PCI network adapters are bus masters”

?? 20.18, “Device Bay-type network adapter meets PC 2001 requirements”

?? 20.19, “If implemented, USB or IEEE 1394 device meets specifications for network communications devices”

For an integrated cable modem exposing an ATM interface, the following requirements must be met as defined in “Network Adapter Requirements” earlier in this chapter:

?? 20.7, “Adapter uses NDIS 5.0 miniport driver” for connection-oriented media

For an integrated cable modem exposing an Ethernet interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

?? 20.7, "Adapter uses NDIS 5.0 miniport driver"

?? 20.14, "Adapter supports filtering for at least 32 multicast addresses"

?? 20.15, "Adapter and driver support promiscuous mode"

[20.29] Integrated cable modem exposes an ATM or Ethernet interface

An integrated cable modem must expose an ATM or Ethernet interface to the operating system. For the specific requirements if an ATM/cable modem solution is implemented, see "~~ATA~~ ATM Adapter Guidelines" later in this chapter.

ATM Adapter Guidelines

This section summarizes requirements for ATM hardware.

The NDIS 5.0 extensions provide kernel-mode NDIS 5.0 client drivers with direct access to connection-oriented media such as ATM. The new architecture for Windows 98 and Windows 2000 extends native ATM support to Windows Sockets 2.0 (WinSock), Telephony API (TAPI), and DirectShow-based applications by providing system-level components that map the applicable WinSock, TAPI, and DirectShow APIs to NDIS 5.0, extending direct ATM access to user-mode applications.

If ATM is included in a PC 2001 system or is specifically designed for Windows 98 or Windows 2000, it must meet the requirements defined in this chapter. For basic requirements for Plug and Play, power management, and driver support, see "PC 2001 Design for Network Communications" later in this chapter.

For more information related to these requirements, please refer to "ATM Layer Specification," in *ATM User-Network Interface Specification, Version 3.1*. This specification includes references to other relevant specifications.

[20.30] ATM adapter meets PC 2001 network adapter requirements

The following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

?? 20.7, "Adapter uses NDIS 5.0 miniport driver" for connection-oriented media

?? 20.10, "Adapter automatically senses presence of functional network connection"

?? 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"

?? 20.13, "Adapter communicates with driver across any bridge"

?? 20.17, “PCI network adapters are bus masters”

?? 20.18, “Device Bay-type network adapter meets PC 2001 requirements” and

?? 20.19, “If implemented, USB or IEEE 1394 device meets specifications for network communications devices”

[20.31] ATM adapter supports a minimum number of simultaneous connections

The Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI) ranges supported by the adapter affect the maximum number of simultaneous connections supported on a system.

This affects the applicability of the adapter to ATM applications such as LAN emulation, where at least one dedicated VC is created between each pair of communicating ATM hosts.

System type	Simultaneous connections
Client (ATM adapter)	64 or more
Client (Integrated ATM/ADSL adapter)	32 or more

A sample driver is provided in the Windows 2000 DDK to guide developers in properly supporting resources to meet this requirement.

[20.33] ATM adapter supports UBR service type

UBR is used by default for standard ATM services such as LAN Emulation and IP over ATM. In addition, PPP is a widely used model for residential network access, and UBR is used by default for PPP-over-ATM virtual circuits. Therefore, ATM adapters must support the UBR service type.

[20.34] ATM adapter supports a minimum number of simultaneously active VBR or CBR connections

Support is required for at least two simultaneously active VBR or CBR connections for basic ATM signaling and management.

Support for at least six VBR/CBR connections is needed for ATM adapters that support multimedia or other traffic that demands QoS.

[20.35] ATM adapter supports traffic shaping

The ATM adapter must support and enforce all the traffic-shaping rules specified for each service type it supports, including CBR, VBR, ABR, and UBR.

This includes enforcement of peak cell rate on UBR virtual circuits, as described in the following requirement.

[20.36] ATM adapter enforces PCR on UBR virtual circuits

ATM adapters can be used to connect the router, remote access, and content servers to the public ATM network. High-speed residential broadband access networks, such as ADSL and cable modem, can enable direct connection, using an ATM virtual circuit, from home or small office computers to these servers.

When the Windows Dial-Up Networking user interface is used to connect from the home ~~or SOHO~~ computer to the remote router or server, a PPP link is established over an ATM virtual circuit, using the UBR service type. When creating the UBR virtual circuit, Windows requests upstream and downstream line rates, or Peak Cell Rates (PCR), equal to the upstream and downstream line rates provided for the user. Windows uses the ATM Interim Local Management Interface (ILMI) protocol to obtain information such as the user's line rates provided by the public network.

To avoid packet loss and ensure efficient network utilization, it is critical that all ATM adapters, integrated ATM/ADSL adapters, and ATM/cable modem adapters enforce requested PCR on UBR virtual circuits.

Because any ATM adapter might be installed in a server to which clients connect through the public network, this requirement applies to all ATM adapters.

[20.37] ATM adapter and driver support dynamic link speed configuration

When connected to a residential broadband network, ATM adapters must restrict the aggregate transmission rate across all active virtual circuits so that it does not exceed the upstream bandwidth provided by the residential broadband network.

Therefore, all integrated ATM/ADSL adapters and ATM/cable modem adapters must support aggregate shaping of upstream bandwidth, according to the provisioned upstream bandwidth, or the trained bandwith, whichever is lower. Some implementations can support rate adoption and lower-than-provisioned rates might be negotiated because of poor line conditions. In addition, because any 25 Mbps ATM adapter might be used to connect to an ADSL network by way of an external ADSL modem, it is required that all 25 Mbps ATM adapters support this as well. This support is optional for ATM adapters with line rates higher than 25 Mbps.

The Windows ATM Call Manager uses ILMI to query the public network to determine the maximum line rates provisioned for incoming and outgoing traffic. The Call Manager then uses the OID_GEN_CO_LINK_SPEED NDIS request (in SET mode) to set the line rate for both incoming and outgoing traffic, within which the adapter can shape the aggregate of all ATM traffic.

[20.38] ATM adapter that supports OAM responds to F4 and F5 loopback cells

Adapters that receive F4 and F5 loopback OAM (Operation and Maintenance) calls must be responded to on adapters that support OAM. This capability is needed for diagnostics. Support for layers F1-F3 is optional.

~~**[20.39] [DELETED] ATM adapter supports buffer chaining (Tx + Rx)**~~

Note to Reviewers: Information about this subject will be in a future draft.

ADSL Guidelines

This section summarizes requirements for ADSL hardware.

Support is provided in the Windows 98 and Windows 2000 operating systems for ADSL adapters and external ADSL modems, such as those using USB, which provide a faster method for moving data over regular phone lines.

The white paper that was jointly developed by over 30 leading ADSL vendors, *An Interoperable End-to-End Broadband Service Architecture over ADSL System, Version 3.0*, discusses end-to-end service interoperability over ATM over ADSL. This paper is available at http://www.microsoft.com/hwdev/devdes/publicnet.htm. The core idea of this white paper (PPP over ATM over ADSL) has been adopted by the ADSL Forum.

[20.41] Integrated ADSL modem meets PC 2001 network adapter requirements

The integrated ADSL modem must meet the following requirements, as defined in "Network Adapter Requirements" earlier in this chapter:

?? 20.10, "Adapter automatically senses presence of functional network connection"

?? 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"

?? 20.13, "Adapter communicates with driver across any bridge"

?? 20.17, "PCI network adapters are bus masters"

?? 20.18, "Device Bay-type network adapter meets PC 2001 requirements"

?? 20.19, "If implemented, USB or IEEE 1394 device meets specifications for network communications devices"

For the integrated ADSL modem exposing ATM interface, the following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter.

?? 20.7, “Adapter uses NDIS 5.0 miniport driver” for connection-oriented media

For the integrated ADSL modem exposing Ethernet interface, the following requirements must be met as defined in “Network Adapter Requirements” earlier in this Chapter.

?? 20.7, “Adapter uses NDIS 5.0 miniport driver”

?? 20.14, “Adapter supports filtering for at least 32 multicast addresses”

?? 20.15, “Adapter and driver support promiscuous mode”

[20.43] ADSL modem supports G.992.2~~UADSL modem supports DMT line encoding~~

ITU G.992.2 defines Universal ADSL. ADSL modems may also support G.992.1.

ADSL modems must:

?? Support wake up events.

?? Enter the L0 state within 3 seconds of detection of the fast retrain signals.

?? Support Full Initialization signals.

The ADSL modem should support Discrete Multi-tone (DMT) line encoding, which both the Universal ADSL Working Group (UAWG) and ANSI recognize as the industry standard for ADSL as the T1.413 Issue 2 specification For information, see http://www.uawg.org.

DMT is required for UADSL implementations. The UAWG has adopted DMT specified by T1.413, with modifications being made for it to work in a splitterless environment.

Wireless Networking

Wireless networking media types enable WAN, LAN and PAN connectivity. This section lists requirements for wireless media, in addition to those listed above in Networking Adaptor Guidelines. For guidelines on Wireless Modems, see Chapter X, “[Chapter title TBD].” For guidelines on HomeRF, see Chapter X, "Home Networking Media."

[NEW.20.106] Wireless networking media adapters support wireless extensions to NDIS

These are documented in “Network-Dependent Wireless Objects” in Network Drivers in the Windows 2000 DDK. These extensions are based on the work of the Portable Computer and Communications Association, published in PCCA-STD-201, and available on the web at http://www.pcca.org.

[NEW.20.107] IEEE 802.11 Wireless Networking Adaptors support 11Mb/s

IrDA Guidelines for Network Communications

The interface between Infrared Data Association (IrDA) hardware (framers) and the Windows IrDA stack is through NDIS 5.0 miniport drivers that adhere to the conventions defined in *Infrared Extensions to the NDIS Version 4.0 Functional Specification*. The Windows IrDA stack expects that hardware and NDIS drivers deal with framing, transparency, and error detection, as well as supporting media-sense and speed-change commands. Miniport drivers are responsible for discarding incoming frames with bad cyclic redundancy checks. These frames must never be forwarded to the protocol.

Although the IrDA protocol stack in Windows 2000 is different from the one on Windows 98, the Windows 2000 DDK should be used for driver development for both platforms. The Windows 2000 IrDA protocol stack imposes stricter requirements on drivers than the protocol stack on Windows 98.

[20.45] Infrared device meets PC 2001 network adapter requirements

The following requirements must be met as defined in "Network Adapter Requirements" earlier in this chapter:

?? 20.7, "Adapter uses NDIS 5.0 miniport driver"

?? 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"

?? 20.13, "Adapter communicates with driver across any bridge"

?? 20.17, "PCI network adapters are bus masters"

?? 20.18, "Device Bay-type network adapter meets PC 2001 requirements"

?? 20.19, "If implemented, USB or IEEE 1394 device meets specifications for network communications devices"

[20.46] Infrared device supports both FIR and SIR

All infrared devices must comply with approved IrDA specifications, including support for SIR, FIR, and VFIR data devices.

Note to Reviewers: What are the approved IrDA specs you'd want cited and how completely must one comply with them?

[20.47] IrDA hardware supports unattended driver installation

FIR Plug and Play hardware must report a unique Plug and Play ID that matches the combination of the chip set, transceiver, and any other system-specific parameters, for the operating system to find and install the correct INF and the associated driver for the IrDA hardware.

In the best case, the IrDA hardware has only one Plug and Play ID associated INF file and a miniport driver that can autodetect the transceiver type and other system-specific parameters. This combination enables the installation and configuration of the hardware and the driver without user intervention.

In other cases, for example, where the miniport driver cannot autodetect the transceiver type or any other system-specific parameters, a unique Plug and Play ID for each combination of the chip set and the transceiver type must be reported. Also, the vendor must provide for each combination an associated driver and INF file describing the configuration parameters.

Home Networking Guidelines

~~Home networking is a significant new area with different constraints than conventional networking and few products currently on the market. Currently, important applications are sharing Internet access and peripherals, but new applications might develop.~~

~~Because this networking area is so new, it is appropriate that this guide set a standard for the quality of the user experience with as few hard technical standards as possible, allowing time for a marketplace to develop.~~

~~A Desktop PC system must include a modem or other Internet access device. However, in a home with networked PCs, some kind of gateway is desirable to enable simultaneous access to the Internet from multiple clients. Such a gateway can be implemented in PC software or embedded in a non-PC networking solution.~~ In a home with networked PCs, a gateway providing Internet access to multiple clients can be implemented in PC software or embedded in a non-PC networking solution. These gateway functions can include networking services such as DHCP Proxy, NAT Router, and Firewall. All the PCs in this scenario must have a network adapter for peer-to-peer connectivity for accessing the Internet link provided by the home gateway.

~~Although there is no explicit speed requirement for home networking media, designers should recognize that higher bandwidth supports greater capabilities. For example, to support MPEG-2 playback, 1.5 Mbps is needed; however, a full MPEG-2 video stream requires closer to 10 Mbps.~~

~~Home networks will differ from traditional, homogeneous business networks because they are expected to incorporate many types of media and link layer protocols spanning a smaller number of hosts. Even though media types and link layer protocols will be optimized with respect to features such as bandwidth and isochrony, it is important that IP protocols be supported in every case in order to enable traditional PC-to-PC networking.~~

Any home networking media must support IP, yet not preclude the use of other protocols.

Home Networking Media

New networking media types are being invented to make it easy for PC users in homes and small businesses to implement simple LANs without needed to install new wires. This section lists requirements for these media, in addition to those listed above in "Network Adaptor Guidelines." The media types listed here cover wireless and re-use of exising telephone wiring.

Note to Reviewers: If standards are developed for re-use of power wiring or TV cable wiring, they will be added to this section in future revisions of the this guide.

[20.48] If implemented, home networking adapter meets PC 2001 network adapter requirements

The following requirements must be met, as defined in "Network Adapter Requirements" earlier in this chapter:

?? 20.7, "Adapter uses NDIS 5.0 miniport driver"

?? 20.10, "Adapter automatically senses presence of functional network connection"

?? 20.11, "Adapter automatically senses transceiver type"

?? 20.12, "Adapter supports quadword or smaller buffer alignment for receive and byte buffer alignment for send"

?? 20.13, "Adapter communicates with driver across any bridge"

?? 20.18, "Device Bay-type network adapter meets PC 2001 requirements"

?? 20.19, "If implemented, USB or IEEE 1394 device meets specifications for network communications devices"

?? 20.14, "Adapter supports filtering for at least 32 multicast addresses"

?? 20.15, "Adapter and driver support promiscuous mode," for network media that confine network traffic signals within a single home

?? 20.17, "PCI network adapters are bus masters"

[NEW.20.101] System that supports Home RF complies with SWAP specification

If a PC 2001 system that implements Home Radio Frequency (Home RF), it must comply with the Shared Wireless Access Protocol (SWAP) Specification, Version 1.1(or later), available at http://www.homerf.org/tech/. This specification is produced by the HomeRF Working Group.

[NEW.20.104] If implemented, system that supports HomePNA complies with 2.0 specification.

If a PC 2001 system implements Home Phoneline Networking Alliance (HomePNA) technology, it must compliy with the HomePNA 2.0 specification, available on the web at http://www.homepna.org.

The HomePNA 2.0 specification supports 10 Mb/s speed. It also requires backwards compatibility with the HomePNA 1.0 specification.

PC 2001 Design for Network Communications

This section summarizes requirements related to the PC 2001 design initiatives defined in Part 1 of this guide.

Plug and Play and Bus Design for Network Communications

The items in this section are requirements for Plug and Play capabilities.

[20.53] Plug and Play capabilities support multiple adapters

For network communications devices, the Plug and Play IDs and resource support must be sufficient support automatically the addition of multiple network communications devices to the system. This is true both for the same and different types of network communications devices.

[20.54] All resource settings are reported in the user interface

All resource settings must be viewable in the Device Manager and in the adapter properties dialog boxes. All resource settings that can be changed by the user must be changed using the standard Windows user interface, not through the use of INI files or other setting files.

This requirement implies that all device resources must be set and read through the standard interfaces provided by the bus on which the device resides. For PCI devices, this interface is the PCI configuration space. Also, device parameter settings must be stored in the registry.

[NEW.20.103] External Networking devices support standard control interfaces

External networking devices attached via serial bus (USB, USB 2.0 or IEEE 1394) must support standard control interface specifications where applicable.

All external USB networking devices must support USB CDC 1.1.

If implemented, external USB networking adapters must support either:

?? Ethernet connection model (CDC 1.1) or

?? Remote NDIS over CDC 1.1

If implemented, external IEEE 1394 networking adapters must support remote NDIS over SBP-2.

Note to Reviewers: New standards, if applicable, could be added in a future revision of this design guide.

Power Management for Network Communications

This section summarizes the specific power management requirements for network communications devices.

[20.55] Adapter complies with Network Device Class Power Management Reference Specification

The *Network Device Class Power Management Reference Specification, Version 1.0a*, provides definitions of the OnNow device power states (D0–D3) for network adapters. The specification also covers the device functionality expected in each power state and the possible wake-up event definitions for the class.

Network communications devices that directly attach to the PC over USB, PCI, and IEEE 1394 must comply with this specification.

[20.56] Network device supports wake-up events

This requirement applies specifically to the following network communications devices and their associated NDIS 5.0 miniport drivers:

?? Ethernet and Token Ring network adapters

?? Integrated DOCSIS cable modems

?? Other devices that transfer IEEE 802.3/DIX Ethernet framed packets

Network Device Class Power Management Reference Specification does not yet define wake-up mechanisms for ISDN adapters or any network communications adapter that uses ATM signaling.

The system must be capable of wake-up from a lower power state based on network events that are specified by the local networking software. As a result of this capability, any standard Windows network access—such as connections to shared drives and WinSock connections, plus service and management applications—can wake a system from lower power states transparently.

Mobile PC Note

For mobile PCs, network device wakeup is note required.

As defined in *Network Device Class Power Management Reference Specification,* a network adapter and its driver must support wake-up on receipt of a network wake-up frame. Support for wake-up on detection of a change in the network link state or on receipt of a magic packet event is optional. Implementation details are described in the "Network Wake-up Frames" and "Network Wake-up Frame Details" sections of *Network Device Class Power Management Reference Specification, Version 1.0a* and in the Windows 2000 DDK. See also the implementation notes at http://www.microsoft.com/hwdev/devdes/netpm.htm.

The packet patterns that define the wake-up frames are provided to the NDIS 5.0 miniport driver by the operating system. To enable Wake-On-LAN capability for basic networking scenarios, the network adapter must be capable of storing information describing a minimum of three wake-up packet patterns, and it must be able to recognize wake-up packets based on pattern matches anywhere in the first 128 bytes of the packet.

Network adapters must be capable of storing information describing at least five wake-up packet patterns to enable more advanced applications, such as Wake-On-LAN capability on multi-homed systems or on receipt of multicast packets, in addition to the above basic scenarios.

PCI-based network adapters must support the generation of a power management event (PME# assertion) from the D3 cold device state if the physical layer technology is generally capable of operating under the voltage and current constraints of the D3 cold device state. For example, 100baseTX adapters can meet this requirement based on the state of the art available in mid-1998. 1000baseSX or 1000baseLX (gigabit Ethernet using optical fiber media) cannot meet this requirement because of the power required to operate the optical physical layer.

Device Drivers and Installation for Network Communications

This section summarizes requirements for network communications device drivers, in addition to the requirements for using an NDIS 5.0 miniport driver as defined in "System Requirements for Network Communications" earlier in this chapter.

[20.58] Driver works correctly with Microsoft network clients and protocols

This requirement includes the 32-bit Microsoft client and NetWare-compatible clients provided with Windows, whether connected to a Windows 2000-based server, a Novell NetWare 3.*x* or 4.*x* server, or a Windows-based peer server. In all cases, this requirement applies to connections using Microsoft TCP/IP, IPX/SPX-compatible protocol, and NetBEUI in local area networks and TCP/IP in wide area networks.

[20.59] NDIS miniport driver makes only NDIS library calls or WDM system calls

A miniport driver must make calls only to the NDIS library or the WDM system to provide binary compatibility of the driver between Windows 98 and Windows 2000.

NDIS conformance must be validated over a single network connection and multiple connections. For Windows 2000, conformance must be validated on a multiprocessor system as part of compliance testing.

[20.60] NDIS 5.0 driver uses Windows 2000 INF format

All network components must use the INF format defined in the Windows 2000 DDK.

Note: For Windows 2000, the operating system provides no legacy INF support and no satisfactory upgrade option for OEM components created for an earlier version of Windows.

Checklist for Network Communications

[20.7] Network adapter uses NDIS 5.0 miniport driver
[20.8] Intermediate NDIS 5.0 miniport driver is deserialized
[20.10] Adapter automatically senses presence of functional network connection
[20.11] Adapter automatically senses transceiver type
[20.12] Adapter can transmit packets from buffers aligned on any boundary
[20.13] Adapter communicates with driver across any bridge
[20.15] Adapter and driver support promiscuous mode
[20.16] Adapter can be used as a boot device
[20.17] PCI network adapters are bus masters
[20.18] Device Bay-type network adapter meets PC 2001 requirements
[20.19] If Implemented, USB or IEEE 1394 device meets specifications for network communications devices
[20.50] Networking media supports Internet Protocol (IP)
[20.20] [MOVED] Network adapter and driver supports priority for IEEE 802-style networks
[20.9] Full-duplex adapter automatically detects and switches to full duplex mode
[20.14] Adapter supports filtering for at least 16 multicast addresses
[20.20] Network adapter and driver supports priority for IEEE 802-style networks
[20.21] Internal ISDN device meets PC 2001 network adapter requirements
[20.22] Internal ISDN device supports synchronous HDLC framing
[20.23] NDIS interface and driver support raw unframed synchronous B channel I/O
[20.24] ISDN driver supports unattended installation, with limitations
[20.26] ISDN device includes software-selectable terminating resistors
[20.28] Integrated cable modem meets PC 2001 network adapter requirements
[20.29] Integrated cable modem exposes an ATM or Ethernet interface
[20.30] ATM adapter meets PC 2001 network adapter requirements
[20.31] ATM adapter supports a minimum number of simultaneous connections
[20.33] ATM adapter supports UBR service type
[20.34] ATM adapter supports a minimum number of simultaneously active VBR or CBR connections
[20.35] ATM adapter supports traffic shaping
[20.36] ATM adapter enforces PCR on UBR virtual circuits
[20.37] ATM adapter and driver support dynamic link speed configuration
[20.38] ATM adapter that supports OAM responds to F4 and F5 loopback cells
[20.41] Integrated ADSL modem meets PC 2001 network adapter requirements
[20.43] ADSL modem supports G.992.2
[NEW.20.106] Wireless networking media adapters support wireless extensions to NDIS
[NEW.20.107] IEEE 802.11 Wireless Networking Adaptors support 11Mb/s
[20.45] Infrared device meets PC 2001 network adapter requirements
[20.46] Infrared device supports both FIR and SIR
[20.47] IrDA hardware supports unattended driver installation
[20.48] If implemented, home networking adapter meets PC 2001 network adapter requirements
[NEW.20.101] System that supports Home RF complies with SWAP specification
[NEW.20.104] If implemented, system that supports HomePNA complies with 2.0 specification.
[20.53] Plug and Play capabilities support multiple adapters

[20.54] All resource settings are reported in the user interface

[NEW.20.103] External Networking devices support standard control interfaces

[20.55] Adapter complies with Network Device Class Power Management Reference Specification

[20.56] Network device supports wake-up events

[20.58] Driver works correctly with Microsoft network clients and protocols

[20.59] NDIS miniport driver makes only NDIS library calls or WDM system calls

[20.60] NDIS 5.0 driver uses Windows 2000 INF format

CHAPTER 15

Printers

INDUSTRY REVIEW DRAFT FOR V.0.5 — SAVED: 11/02/1999 2:39 PM–

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

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This chapter presents the PC 2001 requirements for printers. ~~Printers and other devices attached to parallel ports should be capable of high-speed, bi-directional data transfers. The design criteria for parallel devices follows the design criteria for parallel ports as described in "Parallel Port Requirements" in Chapter 13, "I/O Ports and Devices."~~

The goal of the PC 2001 requirements for printers ~~and parallel ports~~ is to ensure the following:

?? Maximum speed for transfer of ~~parallel~~ data between the system and the peripheral

?? A true Plug and Play experience for users

?? High-quality color matching between display and color output devices

Basic Printer Features

This section summarizes the basic PC 2001 hardware requirements for printers.

[NEW.21.101] Device uses PC 2001 compatible port connection with USB or IEEE 1394 connection

All printers must use PC 2001 compatible port connections.

PC 2001 requires the use of either USB or IEEE 1394 for printers. No proprietary solutions are acceptable for PC 2001. Other port connections may be present on the device, but the port connection must be PC 2001 compatible.

USB printers must conform to the *Universal Serial Bus Device Class Definition for Printing Devices, Version 1.1* or later.

If an IEEE 1284 or serial port connection is included on the printer, that connection must meet the requirements defined in *Legacy Plug and Play Guidelines* (http://www.pcdesguide.org/library.htm), which defines the requirements for these connections contained in earlier versions of the system design guide.

[21.1.] [REDUNDANT]IEEE 1394 Printer meets PC 2001 requirements for IEEE 1394

Note to Reviewers: Redundant with general rqmt that a device has to meet the basic requirements for its connection

[21.2.] [REDUNDANT]USB Printer meets PC 2001 requirements for USB devices

Note to Reviewers: Redundant with general rqmt that a device has to meet the basic requirements for its connection

[21.3.] [REDUNDANT]IEEE 1284 Printer supports compatibility mode, nibble mode, and ECP, compliant with IEEE 1284-I

Note to Reviewers: Redundant with general rqmt that a device has to meet the basic requirements for its connection

[21.4.] [REDUNDANT]IEEE 1284 printer meets IEEE 1284-II requirements

Note to Reviewers: Redundant w/ “legacy PnP” rqmt

[21.5.] [REDUNDANT]ECP printer works correctly when ECP mode is turned off

Note to Reviewers: Redundant w/ “legacy PnP” rqmt

[21.6.] [REDUNDANT]IEEE 1284 hardware supports error notification

Note to Reviewers: Redundant w/ “legacy PnP” rqmt

[21.7] Daisy-chained parallel port device is Plug and Play capable

The daisy-chained parallel port device must be capable of answering Plug and Play requests from the host. Because of end-of-chain issues with IEEE 1284 and IEEE 1284.3, all pass-through devices must comply with IEEE 1284.3.

[21.8] Network printer supports standard port monitor

Network-connected printers must support TCP/IP standards such as Line Printer Remote (LPR) and Line Printer Daemon (LPD) (RFC 1179), Port 9100 printing (raw mode printing), or both types.

PC 2001 Printer Design

This section summarizes requirements related to the PC 2001 design initiatives in Part [X] of this guide.

Plug and Play for Printers

The items in this section are requirements for Plug and Play capabilities. For Plug and Play requirements related to the printer port on the PC, see Chapter [X], "I/O Ports and Devices," or the related bus port requirements in Part [X] of this guide.

[21.9] Plug and Play support implemented for all supported buses

Complete Plug and Play support must be implemented for all buses that the device supports. Each print device must have a unique Plug and Play ID. For information about the Plug and Play requirements, see *Legacy Plug and Play Guidelines* available at http://www.pcdesguide.org/library.htm.

Note to Reviewers: The *Legacy Plug and Play Guidelines* are not yet available here.

[21.10.] [REDUNDANT]Peripheral device meets IEEE 1284 requirements

Note to Reviewers: Redundant w/ "legacy PnP" rqmt

Device Drivers and Installation for Printers

This section summarizes device driver requirements for printers. The items in this section are requirements for all PC 2001 systems.

[21.11] Printer INF file and installation meet PC 2001 requirements

Each device requires a printer INF file for both Windows 98 and Windows 2000 operating systems. The manufacturer does not need to supply a printer INF file if a standard printer INF file provided with the operating system can be used.

If the manufacturer provides an INF file, it must be complete and free of errors. This INF file must comply with the printer-specific extensions listed in the Windows 98 DDK and Windows 2000 DDK and requirement xxx.

~~If the manufacturer supplies an INF file or another file, it must comply with 3.16, "Device driver and installation meet PC 2001 requirements."~~

Note to Reviewers: This item will be xreferenced with the guideline that was 3.16 in PC 99.

[21.12] Driver correctly reports device capabilities

The driver must correctly support the DEVMODE structure as defined in the Windows 98 DDK and Windows 2000 DDK.

[21.13] Driver supports error notification

At a minimum, the device driver must support notifying the user of errors reported by the hardware.

[21.14] Driver supports sRGB output and has an ICC profile ~~color management~~

Windows 98 and Windows 2000 support using color profiles that comply with the International Color Consortium (ICC) Profile Format specification. The device either must create sRGB output or must embed the ICC profile for the newly acquired image into the image file to identify the color-space information for that image.

For contact information on device profiles, see "Printer References" at the end of this chapter. The Integrated Color Management (ICM) APIs and functionality for Windows are described in the Microsoft Platform SDK and the Windows 2000 DDK.

Color-capable devices such as desktop monitors, printers, scanners, still-image cameras, LCDs, color plasma displays, or other flat-panel devices are required to install one or more ICC profiles for ICM. Providing a monitor color-calibration utility is recommended for generating, editing, and installing ICC profiles. The sRGB profile is distributed with Windows 98 and Windows 2000. Devices that are sRGB compliant are not required to associate a profile.

[NEW.21.102] Printer meets Delta E tolerance requirements for color matching

For sRGB imaging with perceptual or colorimetric rendering, the following tolerances are required:

?? Mean Square Root (MSR) less than or equal to 45

?? Average Delta E less than or equal to 12

?? Numbers be must lower than "ICM OFF" condition

For non-sRGB image files (for example, G1.8, D50), the following tolerances are required:

?? MSR less than or equal to 55

?? Average Delta E less than or equal to 18

?? Numbers be must lower than “ICM OFF” condition

Note to Reviewers: This new requirement establishes a measurable baseline for testing color matching quality.

[21.15] Port monitor software meets DDK guidelines

Any port monitor or language monitor software provided with a print device must accurately report errors and support bi-directional communication as defined in the Windows 98 DDK and Windows 2000 DDK.

[21.16] Driver supports point-and-print network installation

The user must be able to install a driver from a server by double-clicking on the printer share icon.

[21.17] Device is available immediately following installation

The user must not have to restart the system after device installation in order to print.

[21.18] Device supports accurate printable regions

The printable regions that can be selected in the user interface must be accurately supported in the actual print output.

[21.19] Driver supports required DDIs

Printer drivers must ensure that print commands from Win32- and Win64-based applications are executed correctly on the specified printer or plotter. Because these APIs are not hardware-specific, it is the job of each printer driver to interpret the commands for its specific hardware.

For Windows 2000 drivers, the required device driver interfaces (DDIs) are defined in the Windows 2000 DDK — see the “Part 3: Printer Drivers and Spooler Components” in the “Graphics Drivers” section (online at http://www.microsoft.com/DDK/DDKdocs/win98ddk/printer_0o1h.htm).

For Windows 98 drivers, this requirement includes correct support of all features advertised for the device, plus required support for Windows features. The required DDIs for Windows 98 drivers are listed in the “Printer Driver Overview” section of the Windows 98 DDK (online at http://www.microsoft.com/DDK/DDKdocs/win98ddk/printer_0o1h.htm).

This includes the following support, in addition to other support defined in the DDK:

?? TrueType glyph indexes

?? Big fonts (those that require more than 64K to express)

?? Enhanced metafile (EMF) spooling

?? Bezier curve output

?? Services from the Windows device-independent bitmap (DIB) engine

[NEW.21.103] Printer driver does not run in kernel mode

Printer drivers must run only in user mode. Drivers that run in kernel mode can incur stability problems. For driver implementation guidelines, see "Choosing User Mode or Kernel Mode" in the DDK (online at http://www.microsoft.com/DDK/ddkdocs/Win2k/drvarch_2ief.htm).

[21.20] Driver is based on Unidriver

Microsoft provides a universal printer driver (Unidriver) that is capable of carrying out requests such as printing text, rendering bitmaps, or advancing a page on most printer types. To build a driver for a particular printer, a developer builds a minidriver. This minidriver accepts requests from the Graphics Device Interface (GDI) then, in most cases, passes the request to the Unidriver along with information that describes the capabilities, commands, and resident fonts of the particular printer. For more information, see the Windows 2000 DDK and Windows 98 DDK.

Checklist for Printers

[NEW.21.101] Device uses PC 2001 compatible port connection with USB or IEEE 1394 connection

[21.1.] [REDUNDANT]IEEE 1394 Printer meets PC 2001 requirements for IEEE 1394

[21.2.] [REDUNDANT]USB Printer meets PC 2001 requirements for USB devices

[21.3.] [REDUNDANT]IEEE 1284 Printer supports compatibility mode, nibble mode, and ECP, compliant with IEEE 1284-I

[21.4.] [REDUNDANT]IEEE 1284 printer meets IEEE 1284-II requirements

[21.5.] [REDUNDANT]ECP printer works correctly when ECP mode is turned off

[21.6.] [REDUNDANT]IEEE 1284 hardware supports error notification

[21.7] Daisy-chained parallel port device is Plug and Play capable

[21.8] Network printer supports standard port monitor

[21.9] Plug and Play support implemented for all supported buses

[21.10.] [REDUNDANT]Peripheral device meets IEEE 1284 requirements

[21.11] Printer INF file and installation meet PC 2001 requirements

[21.12] Driver correctly reports device capabilities

[21.13] Driver supports error notification

[21.14] Driver supports sRGB output and has an ICC profile

[NEW.21.102] Printer meets Delta E tolerance requirements for color matching

[21.15] Port monitor software meets DDK guidelines

[21.16] Driver supports point-and-print network installation

[21.17] Device is available immediately following installation

[21.18] Device supports accurate printable regions

[21.19] Driver supports required DDIs

[NEW.21.103] Printer driver does not run in kernel mode

[21.20] Driver is based on Unidriver

CHAPTER 16

Digital Still Image Peripherals

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IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

Contents

This chapter presents the PC 2001 requirements for digital still image peripherals, including but not limited to digital cameras and scanning devices such as sheet-fed, flatbed, handheld, film, and fingerprint scanners.

For an overview of the design and market issues, see "Scanner and Digital Still Image Device Issues" in [PC 2001 Design Initiatives reference TBD].

Note to Reviewers: The still image initiative information is under consideration for draft 0.7 of this document.

Digital Still Image Architecture

Windows Image Acquisition (WIA), a Windows Media Services technology, is both an application programming interface (API) and a device driver interface (DDI) for Windows operating systems. WIA provides a mechanism to enumerate available image acquisition devices, both local and remote.

The WIA DDI is designed to minimize the amount of code a hardware vendor must write, while maintaining the flexibility to craft individual solutions. This is accomplished by:

?? Providing a standard device services library that performs most driver operations.

?? Promoting industry device communications standards so that one WIA driver will support most WIA devices. For example, ISO 15740 from PIMA/IT10.

?? Not requiring that the device driver use the standard device services library, while allowing it to support custom interfaces, if needed. However, drivers will still need to implement the standard WIA interfaces.

WIA is implemented as a DCOM out-of-process server to ensure the robust operation of client applications. WIA has three main components:

?? The device manager enumerates imaging devices, retrieves device properties, sets up events for devices, and creates device objects.

?? The device service library implements all services that are device independent.

?? The device minidriver maps WIA properties and commands to the specific device.

The WIA architecture is built upon the foundation established by the Microsoft Still Image Architecture (STI), based on the WDM introduced in Windows 98. WIA device drivers will be compliant with STI's User Mode Driver (USD) model, allowing backward compatibility with Windows 98 and Windows 2000 operating systems.

Implementation details are provided in the Windows 2000 DDK. More information about this architecture is available at http://www.microsoft.com/hwdev/stillimage/.

Note to Reviewers: WIA support will be implemented in the versions of the operating systems following Windows 98 Second Edition and the original release of Windows 2000.

Digital Still Image Devices Basic Features

This section summarizes the basic PC 2001 hardware requirements for scanners and digital cameras.

[22.1] Device uses PC 2001 compatible port connection ~~with USB or IEEE 1394 connection~~

Note to Reviewers: This is proposed as a PC 2001 general requirement, and will be removed from this chapter if it is adopted generally. If it is

not adopted as a general PC 2001 requirement, it will remain a requirement for still image devices.

All still image devices must use PC 2001 compatible port connections, such as SCSI, USB, or IEEE 1394 for all imaging peripherals. No proprietary solutions are available for PC 2001.

~~PC 2001 requires the use of USB for digital cameras that generate uncompressed images of more that 800K pixels. Although digital cameras maintain a serial port interface for mainstream connectivity, the low bandwidth and slow throughput provided by the serial port do not match the bandwidth requirements of megapixel cameras. This creates a less than satisfactory user experience while transferring images to the PC.~~

~~Multiple device support, adequate bandwidth, and ease of connectivity make USB and IEEE 1394 excellent conduits for both digital cameras and scanners.~~

[NEW.22.101] Digital still camera uses PC 2001 compatible port connection with USB or IEEE 1394 connection

PC 2001 must use either USB or IEEE 1394 for digital still cameras. Other port connections may be present on the device, but the port connection must be PC 2001 compatible.

~~All scanners and digital cameras must use PC 2001 compatible port connections. No proprietary solutions are acceptable for PC 2001.~~

Note to Reviewers: This specifically breaks out DSCs from scanners. Scanners can use SCSI.

[22.3] Device ~~Device supports ICC color management~~supports sRGB output and has an ICC profile

Windows 98 and Windows 2000 operating systems support using color profiles that comply with the International Color Consortium (ICC) Profile Format specification. All color output from still-image devices must be defined. The device either must create sRGB output or must embed the ICC profile for the newly acquired image into the image file to identify the color-space information for that image.

For contact information on device profiles, see the references at the end of this chapter. The Integrated Color Management (ICM) APIs and functionality for Windows and Windows 2000 operating systems are described in the Microsoft Platform SDK and the Windows 2000 DDK.

Color-capable devices such as desktop monitors, printers, scanners, still-image cameras, LCDs, color plasma displays, or other flat-panel devices are required to install one or more ICC profiles for ICM. The sRGB profile is distributed in Windows 98 and Windows 2000.

[22.5] Digital still image device with an IR interface uses Fast IR

To improve the customer experience, the use of fast transfer mechanisms is advocated for digital cameras. Every digital camera with an IR interface must support Fast IR and include backward compatibility to Serial IR.

[22.6] Digital still image device with an IR interface provides a secondary PC interface

Devices with an IR interface must provide a secondary interface using a PC 2001 compatible port connection, such as USB or IEEE 1394, to ensure that the widest variety of imaging devices are available for use with PC applications. A non-megapixel IR camera that ships with an IR serial interface adapter complies with this requirement.

Note to Reviewers: The last sentence of previous paragraph will be deleted if PC 2001 final requirements do not allow only legacy interfaces (i.e., IR+serial = 2 legacy interfaces).

Although IR interfaces are increasingly available in desktop systems and especially mobile PCs, many PCs do not include an IR interface.

[22.9] USB device meets ~~PC 2001 USB requirements~~USB imaging device class specifications

All USB hardware must comply with the requirements defined in Chapter 8, "USB," which includes the USB specifications for specific device types.

The USB Imaging Class Device Working Group is working on the USB Still Image Device Definition specification for both digital still cameras and scanners. This specification is expected to be finalized by 2001. Compliance becomes a requirement for PC 2001 within 90 days of when the revision number of the specification reaches version 1.0.

~~This ensures complete Plug and Play capabilities with USB hardware and meets all the core and device requirements for USB. For example, a user must be able to dynamically attach any USB peripheral to any USB connector. The operating system should automatically recognize the device, load and initialize the appropriate drivers, and then make the device available for use.~~

~~with the related USB imaging device class specification becomes a requirement for PC 2001 when the revision number of that specification reaches version 1.0.~~

~~The USB Imaging Class Device Working Group is working on three specifications that, together, will comprise the category "USB Imaging Class," as referred to in *PC 98 System Design Guide*. The first of the specifications expected to reach revision 1.0, expected in Q3 of 1998, is the *USB Video Camera Device Definition*, which addresses digital moving images.~~

Note to Reviewers: This specification is currently at revision 0.8d and expected to reach revision 1.0, in Q3 of 1999. The V.0.9 specification was expected in June 1999. A v.0.9-compliant driver is planned for the next version of the Windows 98 operating system.

~~The other two USB Imaging Class specifications, which will be released after the *USB Video Camera Device Definition*, are the specifications that will contain requirements for still images. The first of these, which may be titled *USB Dual-Mode Video Camera and Digital Still Camera Device Definition*, will contain requirements for still images produced by dual-mode video cameras or digital still cameras. The second of these may be titled~~The USB Imaging Class Device Working Group is also working on the *USB Imaging Class Specification*, which will contains requirements for still images produced by scanners. The USB digital still camera specification is based on ISO 15740, "Requirements for communication with digital photography devices" (http://www.pima.net/it10a.htm#15740).

~~Manufacturers are urged to participate in the USB Imaging Class Working Group. For information, see http://www.usb.org. Also, manufacturers should urge their competitors and peers to join. The more companies that participate in creating the specifications, the sooner they will be released.~~

Note to Reviewers: The USB Still Camera spec is expected to be complete by Q1-2000. Changes update current spec status.

[22.10] [REDUNDANT] USB device supports string descriptors

Note to Reviewers: Redundant with USB bus requirements. See USB guidelines provided in requirement 22.9.

[NEW.22.102] Still image devices meet minimum throughput requirements

Still image devices that implement Fast IR, USB, or 1394 must download images to the PC and make them available through the WIA acquisition interface to applications at a rate of no less than 80, 120, and 200 Kpixels/s, respectively.

[22.13.] [REDUNDANT] USB device follows PC 2001 USB performance recommendations

Note to Reviewers: Redundant w/ general USB requirements

[22.14] Digital camera uses PC-compatible file system for removable storage

For devices that include removable flash memory, a file system that is PC-compatible must be provided. The Flash Translation Layer (FTL) specification is an example of such a file system.

[22.15] Digital camera stores images in JPEG-compressed file format

Enhancing the user experience is essential for the widespread use of digital images. Increasing satisfaction can be accomplished by standardizing on the file format used to store the image inside the camera, providing interoperability between devices and software. JPEG, TIFF, BMP, GIF, and PNG file filters are incorporated in a great number of image and productivity software, providing comprehensive imaging support so that images can be shared.

~~Reducing the time required to transmit and process images will also further the use of digital images. The FlashPix (FPX) file format provides a rich experience with digital images, offering multiple resolution levels and allowing local region edits, improving the user experience. In the future, the FPX file format is expected to be universal, especially in Internet-related imaging.~~A digital still camera must provide the user with the option to store images in a JPEG-compressed format.

[22.16.] [REDUNDANT] IEEE 1394 device meets PC 2001 requirements for IEEE 1394a

[New.22.104] Still image devices deliver accurate image information

Imaging devices must resolve at least 1/4 line per claimed pixel resolution in both the horizontal and the vertical direction to ensure greater image capture accuracy. This requirement applies to the device's best quality setting.

PC 2001 Design for Digital Still Image Devices

This section summarizes requirements related to the PC 2001 design initiatives described in Part [X] of this guide.

Plug and Play for Digital Still Image Devices

The items in this section are requirements for Plug and Play capabilities. For Plug and Play requirements related to parallel ports, see Chapter [X] "I/O Ports and Devices," or the related bus port requirements in Part [X] of this guide.

[22.17] If implemented, serial ~~device~~connection complies with Plug and Play External COM Device Specification v. 1.0

A PC 2001 device cannot use a serial connection as the sole connectivity option.

If a serial interface is implemented in addition to other connectivity options such as USB, the device must provide full Plug and Play support for PC connectivity using serial enumeration.~~Serial enumeration provides a mechanism to support automatic configuration capability for peripheral devices that connect to a PC using Asynchronous Serial Data Interchange on standard serial ports, commonlyknown as COM ports.~~

For information, see the *Plug and Play External COM Device Specification, Version 1.0,* available at http://www.microsoft.com/hwdev/respec/pnpspecs.htm.

[22.18.] [REDUNDANT] Plug and Play capabilities implemented for all supported buses

[22.19.] [REDUNDANT] Each device has a Plug and Play device ID

[22.20] Daisy-chained parallel port imaging devices must be Plug and Play capable

Daisy-chained parallel port devices, such as scanners, must be Plug and Play capable as defined in Chapter [X], "I/O Ports and Devices." The daisy-chained parallel port device must be capable of answering Plug and Play requests from the host. Because of end-of-chain issues with IEEE 1284 and IEEE 1284.3, it is also required that all pass-through devices comply with IEEE 1284.3.

[NEW.22.103] USB camera firmware supports ISO 15740 protocol

A USB camera does not need to supply a WIA driver if the camera firmware supports ISO 15740.

ISO 15740 defines a common protocol for all digital still cameras, ensuring PC connectivity using a generic driver provided with the Windows operating system. This protocol is an international standard supported by imaging industry leaders. ISO 15740 ensures interoperability of digital still cameras, including PC and peer-to-peer connectivity.

For information, see the draft for ISO 15740, "Requirements for communication with digital photography devices" at http://www.pima.net/it10a.htm#15740. When the standard becomes final, it will be available from ISO. See also the implementation guidelines in the Windows 2000 DDK.

Note to Reviewers: Transport implementations for future versions of Windows operating systems are under development. Microsoft is investigating providing transport drivers for USB, IR, and 1394. Vendors will be able to access their extensions to the protocol by writing a dynamic add-on component to the generic WIA driver provided in Windows.

This ensures device will work with built-in generic driver; matches USB imaging spec baseline

Digital Still Image Device Power Management

This section summarizes the specific power management requirements for scanners and digital still image devices.

[22.21] Device supports power management requirements for its bus

The device must support the power management requirements for the bus it uses, as defined in Part [X] of this guide.

Device Drivers and Installation for Digital Still Image Devices

This section summarizes the device driver requirements for scanners and digital still image devices.

[22.22.] [REDUNDANT] Device drivers and installation meet PC 99 requirements

[22.23] Driver support is implemented under the ~~Still Image~~WIA driver architecture

Still image devices must provide drivers based on the Windows Image Acquisition architecture (WIA). The services provided by WIA provide hardware abstraction, installation wizards, and event polling.

Note: The IR bus interface is exempt from this requirement.

Tethered still image devices capable of creating video streams also must provide a WDM minidriver based on WDM Stream class support.

For information about the WIA architecture and the WDM Stream Class support, see the Windows 2000 DDK. See also the related articles on the web site at http://www.microsoft.com/hwdev/stillvideo/.

Note to Reviewers: Matches architecture planned for OS release in PC2001 timeframe

[22.24.] [REDUNDANT] Applications provided with the device meet Win32 specifications

[22.25] Device driver supports TWAIN 1.7 or later

For those devices that ship a TWAIN datasource, the device must support TWAIN v. 1.7 or later, ensuring it can run without a hardware-specific user interface and download *n* number of images at a single time.

~~Note: fingerprint scanners are excluded from this requirement.~~

Note to Reviewers: Fingerprint scanners don't ship with TWAIN datasources.

[22.26] Digital still image device with an IR interface uses the Windows Sockets interface

Windows 2000 does not provide support for IrComm-based devices. For imaging devices that include an IR interface, an IR driver must be provided that is based

on the Windows Sockets interface. For more information, see "Wireless Component Requirements" in Chapter [X], "I/O Ports and Devices."

Exception: Cameras that support IrTran-P v1.0 or higher are not required to provide a Windows Sockets interface-based driver.

Note to Reviewers: This should be part of the IR requirements section. This will be removed in a future draft.

[22.27] Asynchronous imaging device with an IEEE 1394 interface uses SBP2Port

SBP2Port is the IEEE 1394/SPB2 protocol/transport driver in the Windows 98 and Windows 2000 operating systems. It provides transport services for SCSI-like commands over IEEE 1394. Asynchronous imaging devices must use SBP2Port to communicate over IEEE 1394 if converting the device from a SCSI or SCSI-like interface.

Implementation details are described in the Windows 2000 DDK.

Note to Reviewers: Change matches current OS driver implementation.

Checklist for Digital Still Image Peripherals

[22.1] Device uses PC 2001 compatible port connection

[NEW.22.101] Digital still camera uses PC 2001 compatible port connection with USB or IEEE 1394 connection

[22.3] Device supports sRGB output and has an ICC profile

[22.5] Digital still image device with an IR interface uses Fast IR

[22.6] Digital still image device with an IR interface provides a secondary PC interface

[22.9] USB device meets USB imaging device class specifications

[22.10] [REDUNDANT] USB device supports string descriptors

[NEW.22.102] Still image devices meet minimum throughput requirements

[22.13.] [REDUNDANT] USB device follows PC 2001 USB performance recommendations

[22.14] Digital camera uses PC-compatible file system for removable storage

[22.15] Digital camera stores images in JPEG-compressed file format

[22.16.] [REDUNDANT] IEEE 1394 device meets PC 2001 requirements for IEEE 1394a

[New.22.104] Still image devices deliver accurate image information

[22.17] If implemented, serial connection complies with Plug and Play External COM Device Specification v. 1.0

[22.18.] [REDUNDANT] Plug and Play capabilities implemented for all supported buses

[22.19.] [REDUNDANT] Each device has a Plug and Play device ID

[22.20] Daisy-chained parallel port imaging devices must be Plug and Play capable

[NEW.22.103] USB camera firmware supports ISO 15740 protocol

[22.21] Device supports power management requirements for its bus

[22.22.] [REDUNDANT] Device drivers and installation meet PC 99 requirements

[22.23] Driver support is implemented under the WIA driver architecture

[22.24.] [REDUNDANT] Applications provided with the device meet Win32 specifications

[22.25] Device driver supports TWAIN 1.7 or later

[22.26] Digital still image device with an IR interface uses the Windows Sockets interface

[22.27] Asynchronous imaging device with an IEEE 1394 interface uses SBP2Port

A P P E N D I X A

Resource Mapping

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Contents

This appendix summarizes assignments for interrupt request (IRQ), direct memory access (DMA), and I/O port addresses used by built-in devices on legacy system boards. This appendix also includes details about required interrupts for "legacy free" PC 2001 systems.

Fixed ISA Interrupts

The following IRQs are used by ISA devices and are considered to be fixed assignments.

Fixed ISA Interrupts

Hardware IRQ	Default assignment
IRQ 0	System timer
IRQ 1	Keyboard
IRQ 2	Second programmable interrupt controller (PIC) cascade
IRQ 3	COM 2
IRQ 4	COM 1
IRQ 5	Sometimes LPT 2—not considered fixed

IRQ 6	Standard floppy disk controller (FDC)
IRQ 7	LPT 1
IRQ 8	Real-time clock/CMOS
IRQ 9	—
IRQ 10	Sometimes COM 4—not considered fixed
IRQ 11	Sometimes COM 3—not considered fixed
IRQ 12	PS/2-style mouse
IRQ 13	Coprocessor
IRQ 14	Primary Integrated Device Electronics (IDE) controller
IRQ 15	Secondary IDE controller

Legacy ISA DMA Assignments

The following table lists DMA channel assignments that are used by legacy ISA devices and are therefore considered fixed.

Legacy ISA DMA Considered Fixed

Hardware DMA	System function (default)
DMA 0	ISA expansion
DMA 1	—
DMA 2	FDC
DMA 3	Extended capabilities port (ECP) parallel port on LPT 1
DMA 4	DMA controller cascading
DMA 5	—
DMA 6	—
DMA 7	—

Legacy ISA I/O Address Assignments

The following table lists I/O addresses that are used by legacy ISA devices and are therefore considered fixed.

Note: Shaded addresses are restricted and must not be used by PC 2001 “legacy free” systems.

Legacy ISA System I/O

I/O Address	Default system function
0000–000F	Slave DMA
0010–0018	System
0001F	System
0020–0021	Master 8259
0040–0043, 0048–004B	Programmable interrupt timer (PIT) #1, PIT #2
0050–0052	System
0060	Keyboard/mouse controller
0061	System control port B
0064	Keyboard/mo use status
0070–0071	Nonmaskable Interrupt (NMI) enable/real-time clock
0081–008B	DMA page registers
0090–0091	System
0092	System control port A
0093–009F	System
00A0–00A1	Slave interrupt controller
00C0–00DE	Master DMA controller
00F0–00F1	Coprocessor busy clear/reset
0170–0177	Secondary IDE controller
01F0–01F7	Primary IDE controller
0201	Joystick interface
0220–022F	Sound Blaster
0278–027A	LPT 2 (XT parallel port 3)
02E8–02EF	Alternate COM (4)
02F8–02FF	COM 2
0330–0331	MPU-401
0376	IDE Controller
0378–037A	LPT 1 (XT parallel port 2)
0388–038B	Frequency modulation (FM) synthesis

03B0–03BB	MDA, EGA/video graphics array (VGA)
03BC–03BE	LPT 3 (XT parallel port 1)
03C0–03DF	EGA/VGA
03E0–03E7	PCIC PCMCIA controllers
03E8–03EF	Alternate COM (3)
03F0–03F7	FDC — excluding 03F6
03F8–03FF	COM 1
0534–0537	Windows Sound System-compatible
0CF8–0CFB	Peripheral Component Interconnect (PCI) ports

Required Interrupts for PC 2001 "Legacy Free" Systems

Interrupt	Description
INT 8	System timer. Used to keep the time-of-day clock updated.
INT 10	Set video mode.
INT 11	Equipment determination. If there are devices that appear as floppy drives (for example, El Torito-capable CD-ROM devices), then: Bit Mask 0x0001 (bit 0) in AL must be set. Bits 6 and 7 must properly indicate the number of floppy drive devices and devices that appear as floppy devices. If there are no devices that appear as floppy drives, then: Bit mask 0x0001 (bit 0) must be clear. Bits 6 and 7 must be set to 0.
INT 13	High-capacity drive support. All subfunctions, including AH = 40h–48h Disk operation notes: ROM BIOS must set the head settle, motor start, and format gap values in the disk table pointed to by interrupt vector 1Eh. Implement the INT 13h AH = 17h call (that is, set the DASD type for format). Support the change line (INT 13h AH = 15h) on INT 13h floppy drives. Support INT 13h AH = 8 (Get Device Parameters). Implement the extended INT 13h services (AH functions 41h - 48h). For INT 13h with AH = 48h for installed floppy drives: If there are no floppy drives attached as INT 13h devices, then INT 13h AH = 48h must fail for all floppy drive numbers (drive 0, in particular). However, INT 13h AH = 8 on drive number 0 (DL== 0)

	must work even if there are no INT 13h floppy drives, and it must return a floppy drive count of 0 in the DL register to indicate that no floppy drives are present. If a floppy drive is an industry-standard 1.44-MB, 3.5-inch drive, then the INT 13h AH = 8 call on the device should not modify the BL register. If the device is something other than an industry standard 1.44-MB, 3.5-inch drive, but is "media compatible" with the 1.44-MB floppy standard, then the INT 13h AH = 8 call on the device should return the parameters for a 1.44-MB industry-standard floppy drive but set the BL register to 10h and return the true "maximum supported capacity" drive parameters on the INT 13h AH = 48h call. For floppy devices that are not "media compatible" with the 1.44-MB floppy standard, the INT 13h AH = 8 call should return the "closest reasonable" parameters, set the BL register to 10h, and return the true "maximum supported capacity" parameters on the INT 13h AH = 48h call. The INT 13h AH = 8 Get Device Parameters call must not turn on the drive motor for floppy drives.

Required Interrupts for PC 2001 "Legacy Free" Systems, continued

Interrupt	Description
INT 15	The following subfunctions are required: AH C0 Get configuration 4F Translate keyboard scan code 87 Copy extended memory 88 Get extended memory size AX C2xx Mouse functions E820 Get system memory map E801 Get memory size
INT 16	The following subfunctions are required: AH 00h Get keystroke 01h Check for keystroke 02h Get control keys 10h Get enhanced keystroke 11h Check for enhanced keystroke 12h Get control keys for enhanced keyboard
INT 19	Bootstrap loader.
INT 1A	The following subfunctions are required: AH 0x RTC 2x-5x CMOS 8x,9x PCMCIA Socket Services 9x PCMCIA Socket Services Ax PCMCIA/CardBus Socket Services AX B1xx PCI BIOS B4xx Plug and Play
INT 1B	CTRL+Break Handler
INT 23	CTRL+C, CTRL+Break Handler